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Canon
SLR CAMERAS

Carl Shipman

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How To Select and Use

CANON SLR CAMERAS

by Carl Shipman

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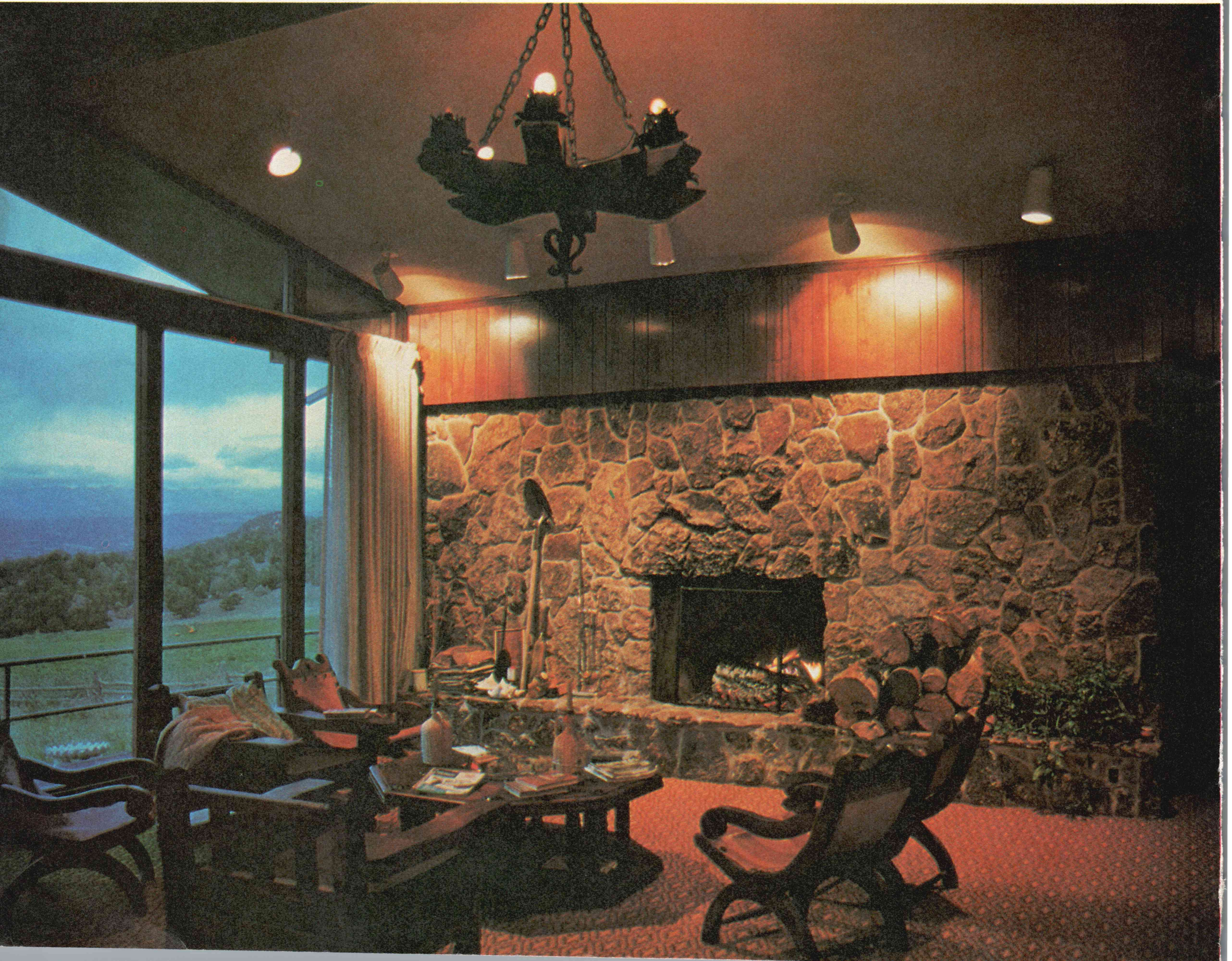
1

PREVIEW

All successful photos solve one or more technical problems. The main problem here was getting fairly good exposure both outdoors and indoors. Solved by waiting for twilight.



FOUR PROBLEMS

Every photograph you take is a trial solution of four problems: Technical, Equipment, Technique, Artistic.

Your photo is a trial solution because it may not work and because there are other possible approaches. When one answer must fit four problems simultaneously, the answer is usually not simple and obvious—part of the fun and interest of photography *and* part of its challenge as a serious hobby or profession.

You are probably already thinking of other picture-related problems—such as when your model falls out of the tree—but those are the main ones. I define them as follows:

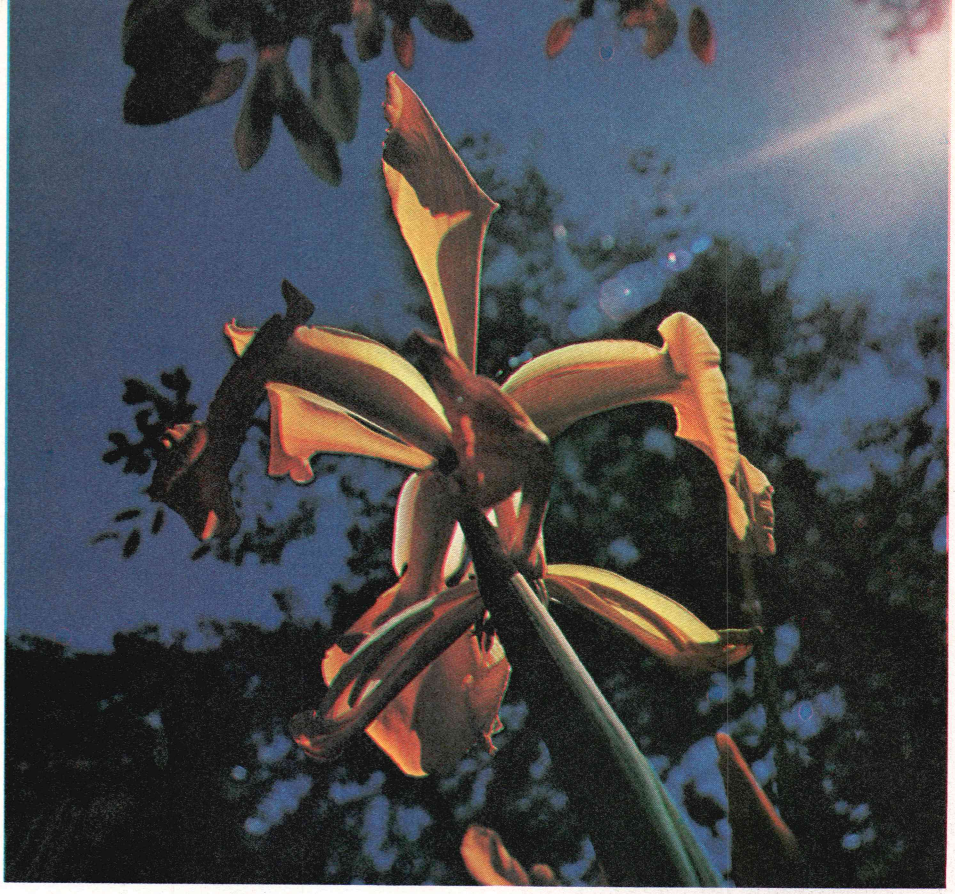
Technical problems relate to films, exposure, light, optics and similar matters. All can usually be solved by application of basic ideas and principles. Formulas, charts and tables supply many of the answers.

Equipment solves most technical problems of photography if a solution is possible. This book is based on the understanding that you plan to use Canon equipment, which is a good choice.

Technique is how you use the equipment. It can be something very simple and general such as not shaking the camera while taking a picture. Or, it can be more challenging: An interesting exposure problem in difficult lighting is one example.

Artistic aspects of photography relate to your intentions regarding the message of the photo and its effect on a viewer. It involves creativity or craft in arranging the elements of a picture and blending the technical factors, equipment and technique to get the result you want. Because the artistic ingredient is based on what *you* want nobody can tell you exactly how to do it.

A more modest goal of this book is to give you mastery of the basic technical facts of photography with a thorough understanding of Canon equipment and the technique of using it effectively. This will help you take good pictures, meaning you have control over every controllable thing.



Art, like beauty, is in the eye of the beholder. This backlit flower may be artistic. Direct sunlight into a lens sometimes causes geometrical *ghost images* of the lens aperture.

Having control and using it effectively are, of course, two different things. In many picture-taking situations, visualization of the desired end result helps in two ways. When you have a preconception of the photo you intend to make, you are much more likely to make a composition and arrrange the lighting so the end result is effective. If you can "see" the complete image in your mind, you are less likely to overlook major or minor things that are part of that image.

A second form of visualization is to "see" in your mind the end result of technical factors and control settings. The world looks different through a wide-angle lens, or a telephoto lens, and so do pictures. When you can visualize the result of using different lenses, shutter speeds, focus settings and camera angles before you make the exposure, you are well on the way to using the technical camera controls in a satisfying and creative way.

This book is both a buyer's guide and a user's guide to Canon equipment. If you are shopping for a camera or accessories, the information about Canon hardware and how to use it culminates in complete specifications in Chapter 18.

The science of photography is only a means to an end. When you set camera controls to get a desired result, the accomplishment is not in setting the controls that way. It is the picture.

Fundamentally, this is not a book about Canon equipment. It is a book about how to take pictures with Canon equipment. I think the distinction is important.

2

THE CAMERAS

Today, Canon cameras can be divided into two groups: A series and F or T models. The main difference is that the A-series cameras use electronics inside to do things formerly done with mechanical parts. Advantages and disadvantages to each type will become apparent as you get farther along in this book. Don't form any conclusions based on which is newer. For now, just consider them different and evaluate the differences.

Camera models for the A series have names which include the letter *A*: A-1, AE-1 and AT-1.

In mid-1978, F&T series cameras include the F-1 and TX. The F-1 is the most expensive, has the most prestige and is considered a camera for professionals although it is widely used by advanced amateurs. The TX is the least expensive and is intended for people who want Canon quality but don't need all of the features found on more advanced models.

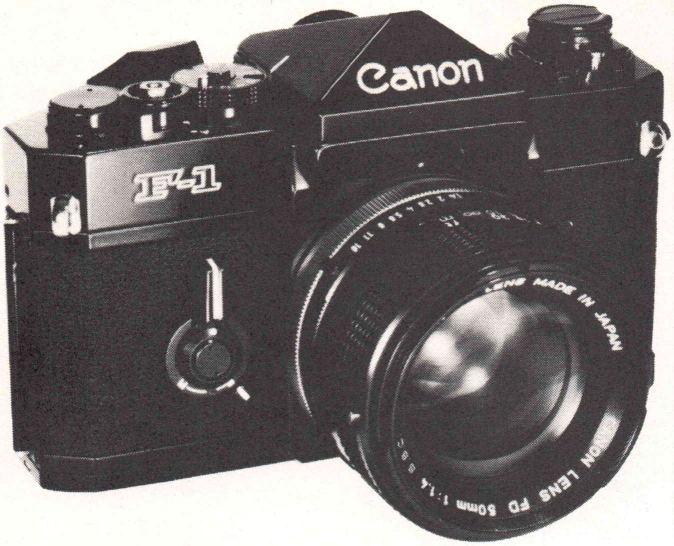
All of these cameras are discussed in this book. In addition, two recent models are included, even though they are no longer made. These are the EF and FTb—both popular and well respected cameras.

Beginning in Chapter 3, there are fundamentals which apply to photography in general and, of course, to Canon equipment. To make some of these fundamentals specific, I use features of Canon cameras as practical examples.

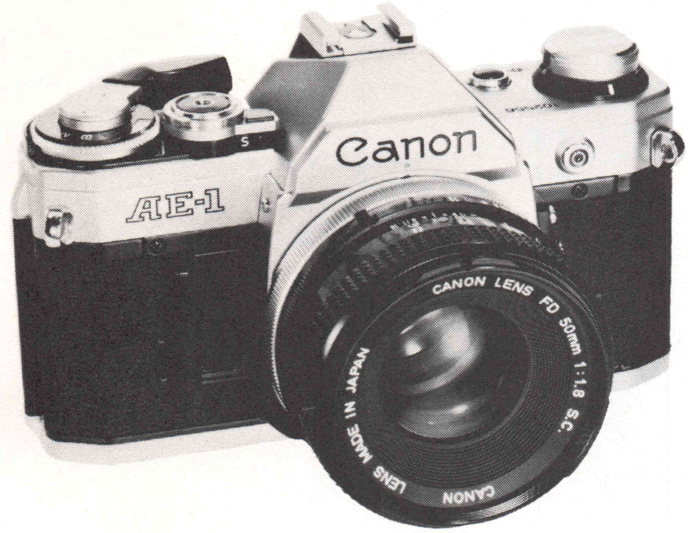
As you proceed through the book, you will get an understanding of technical facts of photography and how they apply to specific camera models. The intent is to convey basic information rather than complete descriptions of each camera model until Chapter 18 where each model is discussed with complete specs and user tips.

By the time you reach Chapter 18, the camera models will be old friends and you will already know a lot about each one. In case you are not now familiar with Canon cameras, here's a brief introduction to each of the currently-manufactured 35mm SLR models and two discontinued models. This is just to get you on a "first name" basis and highlight some camera features that are more thoroughly explained in following chapters.

Introduced in 1978, the Canon A-1 is the most versatile and technically advanced camera ever offered to the general public. It sets exposure for you, automatically, in *five different* ways or modes of operation. Or, you can switch it to non-automatic and set exposure yourself if you want to. The compact A-1 has its own special motor-drive unit, uses two special A-series flash units, and uses many accessories common to the entire line of Canon 35mm cameras. Even though it seems complicated at first, by the time you read the detailed description of the A-1 in Chapter 18, you'll understand all of its features and amazing versatility.


Canon
F-1
CANON LENS FD 50mm 1:1.4
LENS MADE IN JAPAN

The F-1 can use the widest variety of accessories so you can set it up for virtually any photographic assignment. It can use an accessory Motor Drive to advance the film automatically and shoot several frames per second—or expose frames at long time intervals for time-lapse photography. By attaching the Servo EE Finder, this camera can measure the light and set exposure automatically. Many other accessories, described in later chapters, fit the F-1.


Canon
AE-1
CANON LENS FD 50mm 1:1.8 S.C.
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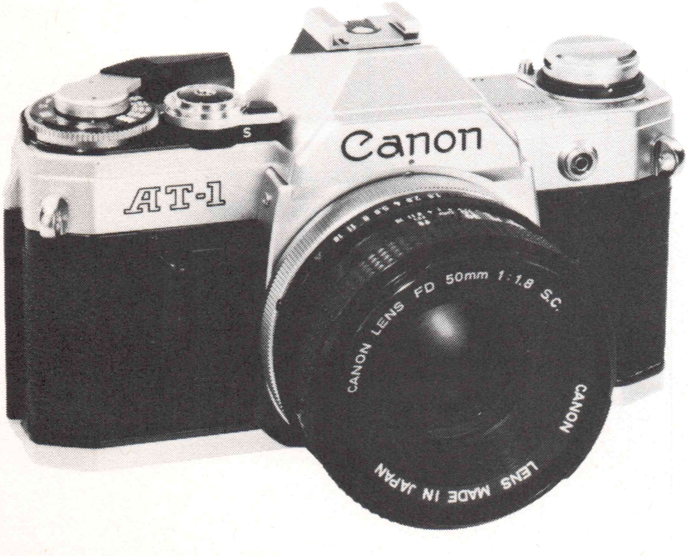
The AE-1 is a compact, automatic camera, introduced in 1976 along with two important accessories—Speedlite 155A which is an advanced automatic flash and compact Power Winder A. These two accessories make photography completely automatic, day or night.

The AE-1 launched a new generation of SLR cameras using computer-style electronics inside to perform tasks formerly done with mechanical parts, do new things that mechanical parts have never done, and reduce size, weight and cost.


Canon
AT-1
CANON LENS FD 50mm 1:1.8 S.C.
CANON
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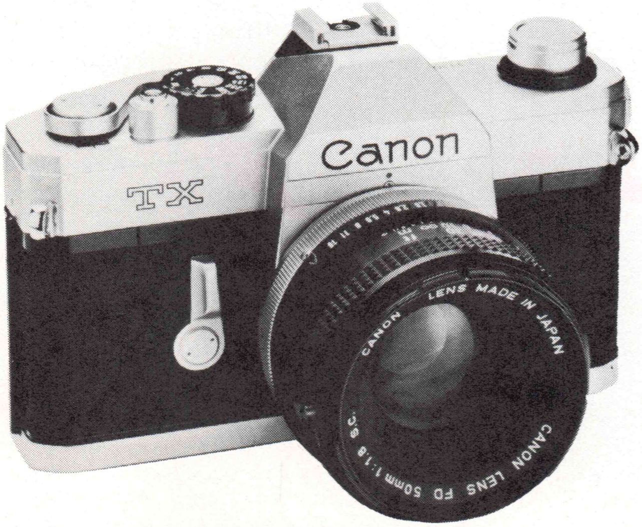
The AT-1, introduced in 1977, is derived from the AE-1. Exposure is not set automatically by the camera. It is done manually by the photographer, with correct adjustment indicated by moving needles in the viewfinder display. The AT-1 is electronic on the inside, similar to the AE-1 and has many of the same features. The AT-1 can use Speedlite 155A and Power Winder A.

The EF is an automatic camera. You select the shutter speed you want to use and the camera automatically adjusts the lens aperture to admit the correct amount of light. Because of a very sensitive light-measuring system using a silicon-blue sensor, this camera can shoot in very dim light—even by candle light. It can time exposures automatically for as long as 30 seconds.

Canon
FTb
QL

The FTb is similar to the F-1 except it uses fewer accessories and is not adaptable to Motor Drive. It's an excellent general-purpose camera, or a second camera for the professional. It is available as shown, or with an all-black body.

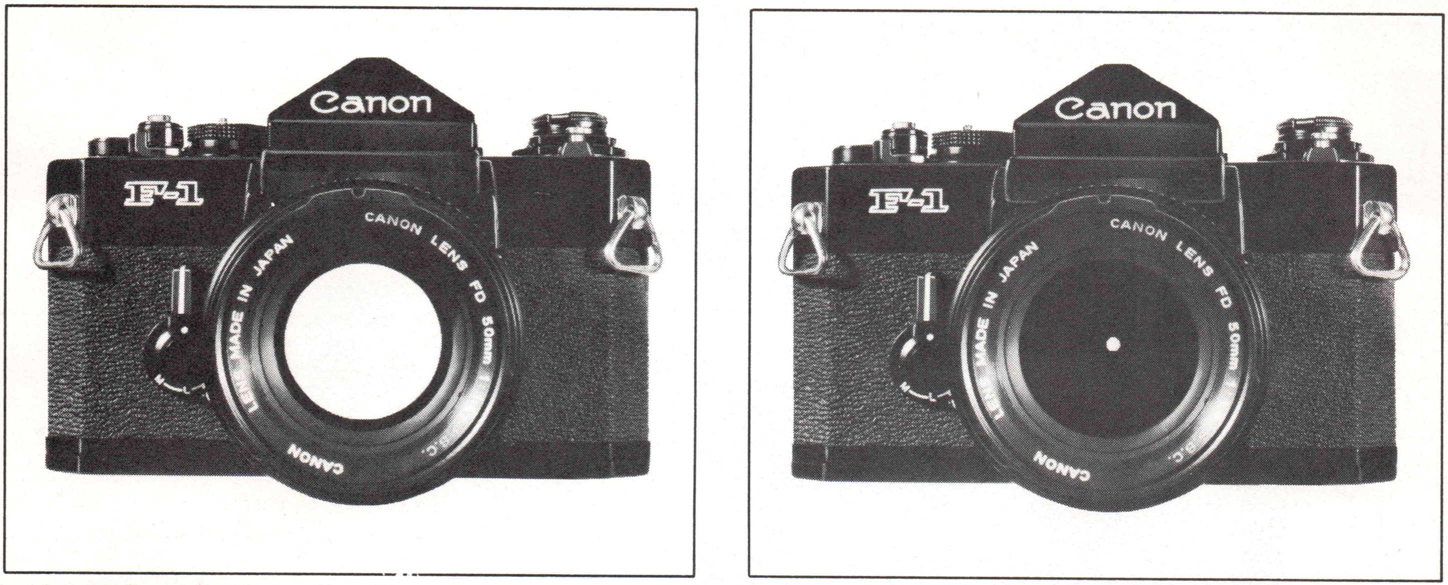


The TX is the lowest-priced of this group. It uses the same interchangeable Canon lenses but has fewer camera features than the FTb. For the casual photographer who wants high-quality pictures, the TX is a good choice.

The TX replaced the TLb which is a similar camera with minor differences explained later. Most of the information in this book applies also to the TLb.

3

EXPOSURE—THE BASIC TECHNICAL PROBLEM



Inside each Canon lens is an adjustable *aperture,* sometimes called a *diaphragm,* which controls the amount of light passing through the lens. At left, aperture is wide open and admits a lot of light to the film. At right, aperture has been changed to a very small opening.

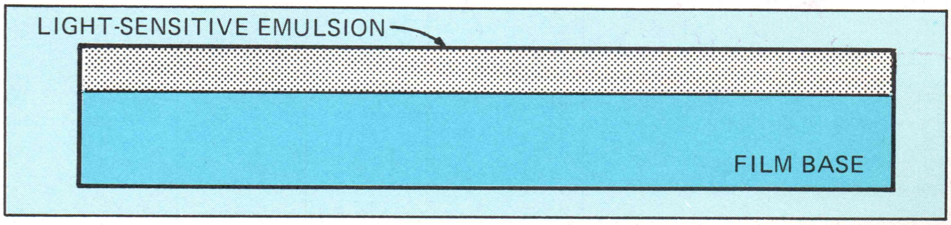
Everything about a camera serves in one way or another to get proper exposure of light onto the film. The camera body excludes stray light or leaks which can affect the film. The lens admits light from the subject being photographed.

One control setting of lenses, called *f-number* or *f-stop* is an indication of *how much* light the lens collects and relays to the film surface. Smaller *f*-numbers allow more light to pass through the lens. This is done by an opening inside the lens which can be made larger or smaller. This adjustable opening is called the lens *aperture.* You change the size of the aperture in the lens by turning a control ring on the outside of the lens unless you are using equipment which controls aperture size automatically.

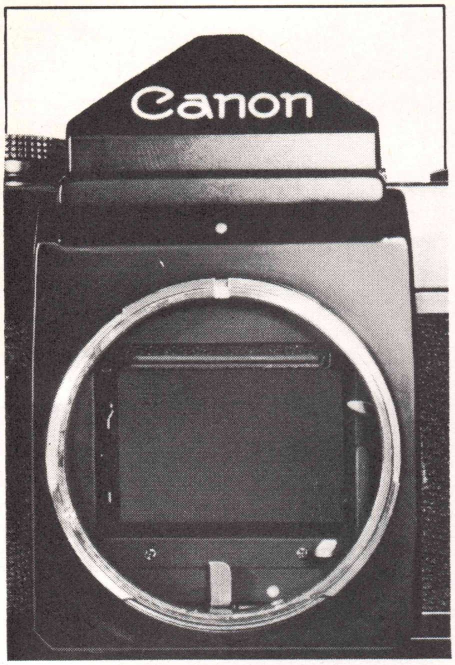
The effect of light on negative film is to create a record of the light pattern in the light-sensitive layer, called *emulsion,* coated onto a clear *base.*

Normally there is no visible change in the film due to exposure until the image is made visible by a chemical procedure called *development.*

Exposure of film to cause an image after development is not just a matter of how bright the light on



The simplest film structure is a light-sensitive layer of emulsion supported by a film base. Most films are more complex than this. Color film, for instance, has three layers of emulsion—each sensitive to a different color.



This F-1 has the lens removed so you can see the focal-plane shutter in the rectangular window near the back of the camera body. The shutter is closed.

the film is. Exposure is determined both by *how bright* the light is and *how long* it is allowed to fall on the film.

The length of time light is allowed to fall on the emulsion is measured in seconds or fractions of a second. It is controlled by a *shutter* inside the camera body, just in front of the film.

The shutter opens to allow light to expose the film. After the desired length of time, it closes again to end the exposure.

RECIPROCITY LAW

The amount of exposure can be expressed by a simple formula which is a basic fact of photography:

Exposure = Illumination x Time

Illumination means the brightness of the light which falls on the film. *Time* is the length of time the shutter is open.

This formula is often written in abbreviated form as: $E = I \times T$, where the letters stand for the words given above. This is called the *reciprocity law.*

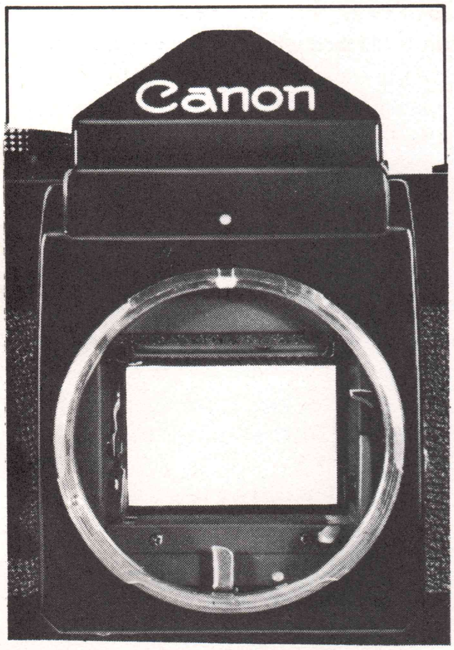
The important thing about the reciprocity law is this:

To get a certain amount of exposure on the film, no particular amount of light is required and no particular length of time is required. The requirement is, the amount of light multiplied by the length of time must equal the desired exposure.

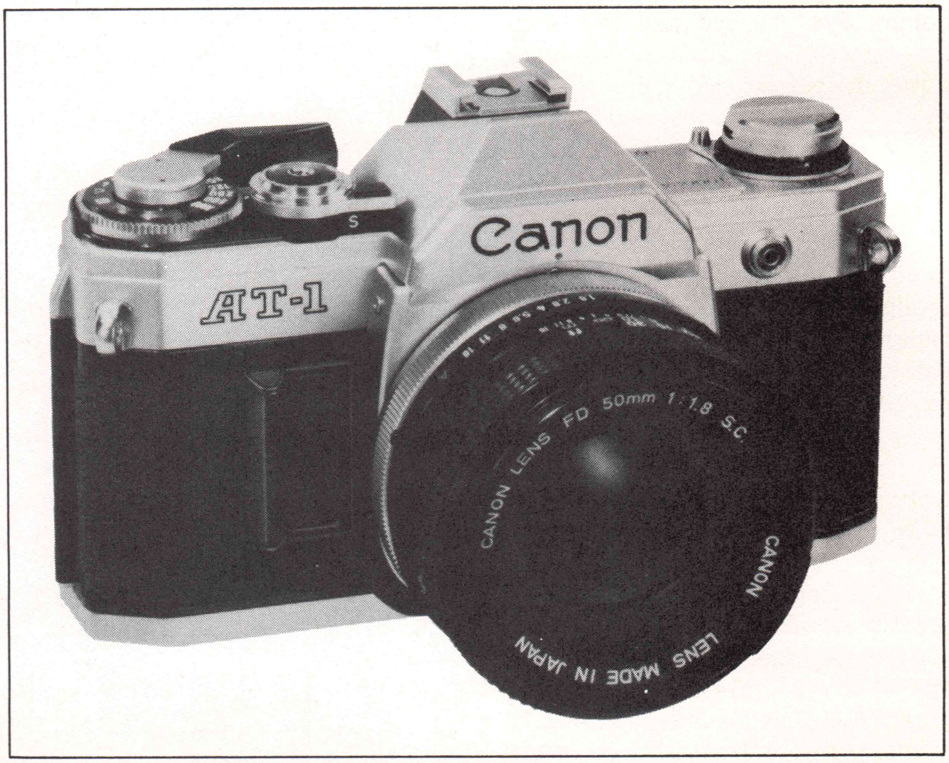
This means you can use less light and more time, or the reverse. When there is not much light, you expose for a longer time so the product of the two values is the desired exposure.

In practical photography it is customary to control both illumination and time by controls on the camera. **When either illumination or time is changed, the camera controls will either double the value or cut it in half.**

This leads to the basic rule for controlling exposure. When you double the amount of light on the film, reduce exposure time to half. When you double the exposure time, cut the amount of light on the film in half. This is the essence of the reciprocity law.



When the shutter is operated, it moves aside to open the light path between lens and film. When the desired exposure time has elapsed, the shutter closes again.



Aperture size and shutter speed are important exposure controls, located so they are easy to operate. Without removing the camera from your eye, you can control aperture setting with your left hand and shutter speed with your right hand.

HOW FILM REACTS TO DIFFERENT AMOUNTS OF EXPOSURE

This discussion of how film responds to exposure applies to any kind of film, color or black and white (b&w). It is simpler to describe and understand when related to b&w film, but the same basic ideas apply also to color film.

If negative film is not exposed at all, but put through development anyway, it will be clear. Not perfectly clear, but practically clear.

Increasing exposure causes b&w film to become increasingly dark when it is developed. It will change from light gray to medium gray to black. There is a limit to how black it can get, just as there is a limit to how clear it can be.

It is convenient to think of changing exposure in a series of definite steps and then observe the amount of darkening which results at each step. The technical word for darkening of the film is *density.*

There's another reason to consider exposure and density as a series of step-increases: We can relate these steps to what the human eye can see and the brain can respond to. There's not much point in getting involved with density changes which nobody can see anyway.

All human senses, including vision, operate in a way that's surprising when you first learn of it. Suppose you are looking at a source of light such as a light bulb. It is making a certain amount of light and it gives you a certain *sensation* or mental awareness of brightness.

Assume the *amount* of light coming from the source is *doubled.* It will look brighter to you. Not twice as bright, but you will notice a definite change.

To make another increase in brightness which you will interpret as the same amount of change, the amount of light must be *doubled again.* Successive increases in brightness which all appear to be equal changes must be obtained by doubling the actual amount of light and continuing to double each value to get the next higher step. This is a fact about the way we *see* and therefore tells us what must be done on film to make *equal steps* of brightness to a viewer of the film.

In photography, we don't worry much about numerical differences between light values or time values. We pay attention to *steps,* defining a step as either double or half of the preceding value, depending on whether we want a *step-increase* or a *step-decrease.*

Figure 3-1 is a test made by exposing each frame on a roll of film at a different exposure, doubling the exposure each time. The subject is a white piece of paper. The result shows how film behaves over a wide range of different exposures which were made in orderly steps for convenience. You can see that the negative reaches a point where it doesn't get any blacker even with more exposure. It also reaches a point where it doesn't get more clear with less exposure.

These two limits of the film—maximum black and maximum clear—are practical limitations in photography. Normally you try to fit the different brightnesses or *tones* of a real-world scene into the range of densitites the film can produce.

This is done by adjusting the

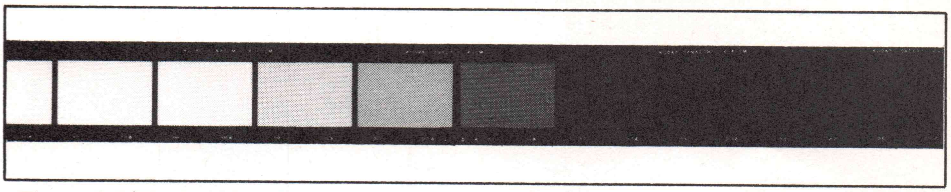
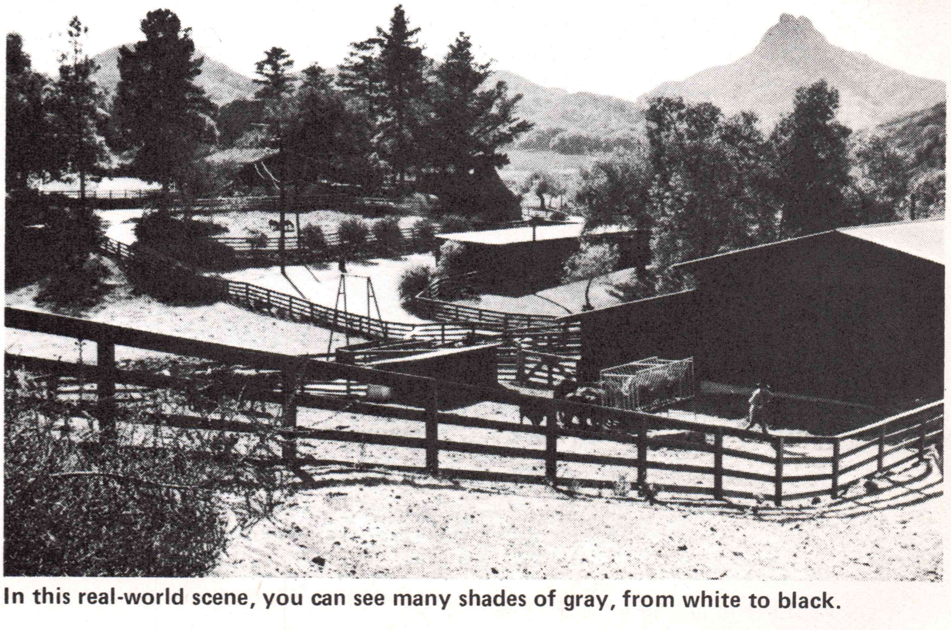


Figure 3-1/Black-and-white photographic materials record shades of gray, ranging from white to black, according to the amount of exposure received. When the amount of exposure is doubled, that is one standard step-increase. Film is often exposed with a series of standard steps for testing. In this series of steps, increased exposure causes this negative film to become darker until a point is reached where additional exposure has no effect. Similarly, reduced exposure makes the film less dense until it finally becomes as white (clear) as it's going to get. Real-world scenes can give any amount of exposure—standard exposure steps or any value in between.



In this real-world scene, you can see many shades of gray, from white to black.

THANKS—This book examines Canon equipment after 40 years of continuing research and progress by the Canon organization. Therefore, I am indebted to a very large number of people for the subject matter and information I have used.

I am particularly grateful to John Wall, Canon Technical Representative, for unlimited assistance in furnishing data, photographs, and equipment. John prepared Chapter 17, helped work out details of the history of Canon equipment, and contributed materially to all other chapters.

Thanks to Mr. Kazuya Ohyama and Mr. Louis Surdin for making time, people and facilities available during preparation of this book. Thanks also to Mr. M. Kakunodate, Vice-President, Technical Marketing, and Mr. Fujio Mitarai, Vice-President and General Manager of Canon U.S.A.

Preparation of this book was aided not only by cooperation of Canon employees but also by Canon's expressed desire to present a completely honest and factual discussion of the equipment—favorable and unfavorable. Unfavorable details are few but they are here, some specifically pointed out by Canon people to be sure I included them. That demands a very special *thank you!*

camera controls with a rather simple idea in mind. The film can produce a range of different densities between maximum and minimum. One of these densities *on the film* is the middle one. The scene you are photographing also has a range of brightnesses or tones which are going to be transformed into densities on the film. One tone *in the scene* is the middle one.

If you arrange exposure so the middle tone of an average scene is transformed into the middle density on the film, exposure is just right. When the negative is made into a print, lighter tones of the scene use lighter densities on the print—above the middle value. Darker tones of the scene use the darker densities of the print.

The only technical problem which can result from exposing film this way is if the brightness range of the scene exceeds the density range of the film. In that case, the film doesn't have enough different densities to match the different brightnesses of the scene. That can happen when part of a scene is in bright light or sunlight and another part is in shadow.

Usually, if you align the middle tone of the scene with the middle density of the film, the scene "fits" the density range of the film. You do this by controlling exposure on the film.

CONTROL OF EXPOSURE

Getting a desired exposure on the film depends basically on three things:

The amount of exposure the film needs—it varies from one type of film to another.

The amount of light reflected toward the camera by the scene or subject.

The settings of the camera exposure controls.

ASA Film Speed—Film manufacturers publish numbers called *ASA Film Speed,* a way of stating the amount of exposure needed by each film type.

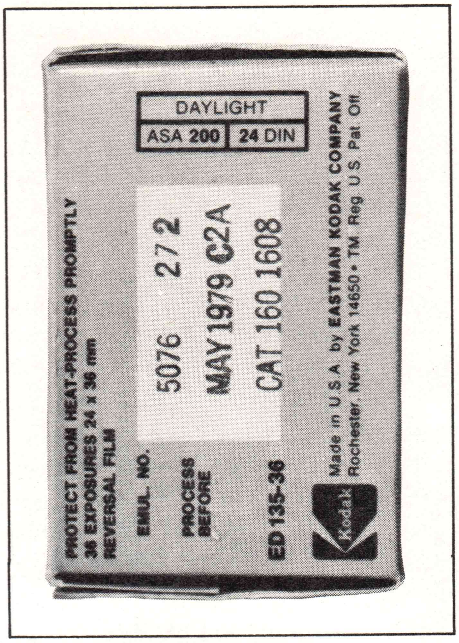
Film speed is a number such as 25 or 400. Higher speed numbers mean the film is more sensitive to light and requires less exposure. Doubling the film-speed number means it requires half as much exposure. Doubling it again requires one-fourth the amount of exposure.

The standard series of ASA Film Speed numbers is 12, 25, 50, 100, 200, 400, and so on. It can be extended in either direction by doubling or halving the numbers.

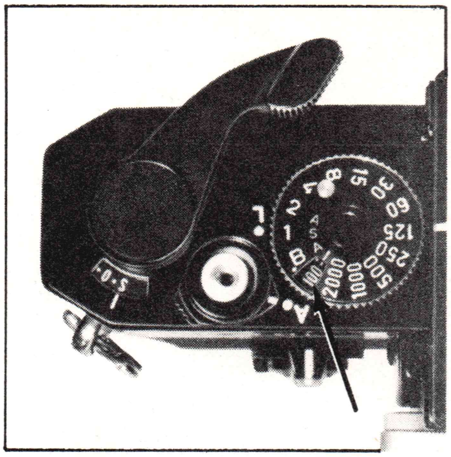
Canon cameras have a film-speed dial on the camera body which you use to set in the film-speed number of the film you are using. This sets the camera to give correct exposure to that film.

Not all films have ASA speed ratings which fall in the series of numbers just given. Some films just don't turn out that way and manufacturers give them intermediate ASA film speed numbers according to the actual exposure needed by the film. Kodak Panatomic X has an ASA speed of 32. Kodachrome 64 has a speed of 64. The film-speed dial on Canon cameras has positions for these speeds and other commonly-used speeds not in the standard series.

Amount of Light from the Scene—After film speed is set into the camera, the next essential is to measure the amount of light reflected by the scene. Canon 35mm cameras do this automatically, inside the camera. They measure light that has come *Through The Lens.*

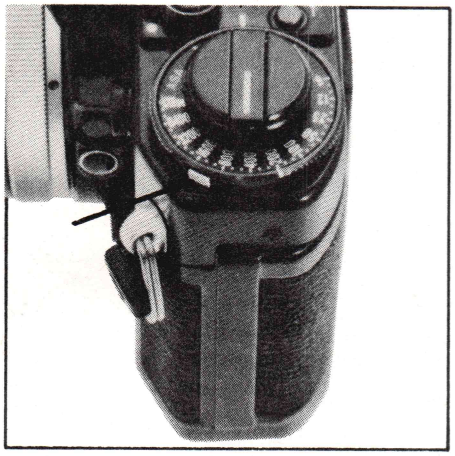


Film is labeled to show its film speed—both on the carton and on the film cartridge inside the carton. Many films give two ratings, ASA and DIN, which are different ways of saying the same thing. Canon cameras use ASA film-speed numbers.



On most Canon cameras, film speed is set by lifting up the shutter-speed dial until it turns freely, then rotating until the desired ASA film-speed number appears in the window on the control (arrow). This camera is set for ASA 100.

When the shutter-speed dial is *not* lifted, rotation changes shutter speed. This camera is set for a shutter speed of 1/125 second.



To set film speed on an A-1 camera, depress the ASA Lock Button with your fingernail while turning the ASA Film-Speed Scale to the desired number. Film-speed range is 6 to 12800. This camera is set for ASA 200.

Exposure Controls—With film speed dialed into the camera, and the amount of light coming through the lens measured inside the camera, the camera itself can now figure the correct settings for the exposure controls. It indicates the correct setting on a display in the viewfinder as you adjust the camera controls. Or, an automatic camera such as the Canon AE-1 or A-1 will make the setting for you.

One exposure control is *lens-aperture size,* adjusted by turning the aperture control ring on the lens. This ring is marked in *f-numbers* and each *f*-number represents an aperture size.

The other exposure control is *shutter speed* or exposure time, set by a dial on top of the camera.

These two exposure controls are used together to arrive at a pair of settings which produces the desired exposure indicated by the viewfinder display. Several pairs of settings can produce the same amount of exposure.

There is an advantage to having several pairs of *f*-numbers and shutter speeds available to make the same exposure on the film. In addition to setting exposure, these controls have other effects on the picture. For example, at slow shutter speeds, meaning long exposure time, subjects in motion can be blurred on the film.

Based on these side-effects of the two exposure controls, the photographer makes settings and shoots the picture. The side-effects are covered in detail later.

THE *f*-NUMBER SERIES

Aperture size is indicated by a standard series of *f*-numbers on the control ring. It is useful and practically necessary to memorize the series, but it is easy to do. See Figure 3-1 on page 12.

Larger *f*-numbers mean smaller lens openings, something you also have to remember.

The series of *f*-numbers is chosen so the area of the opening is doubled with each full *f*-number step-increase, such as from *f*-4 to *f*-2.8. Because the area of the opening doubles, twice as much light passes through. Changing the lens aperture setting in the other direction, such as from *f*-11 to *f*-16 reduces the light to one-half.

Notice there is an approximation between 5.6 and 11. The *f*-number 11 is not exactly double 5.6, but it is close enough and easier to remember.

A couple of examples may help. If you have a lens set at *f*-8 and change it to *f*-11, the amount of light passing through the aperture will be reduced to half. If you change a lens aperture setting from *f*-2 to *f*-1.4, the amount of light on the film will be doubled.

In the early days of photography, variable apertures had not been invented. Cameras used removable metal plates in the light path to the film. The metal plates were made with holes of different size and the thinking was that the plate would *stop* all of the light except that which got through the hole. Changing these plates to allow

6	•	•	12	•	•	25	•	•	50	•	•	100	•	•	200	•	•	400	•	•	800	•	•	1600	•	•	3200	•	•	6400	•	•	12800
	(8)	(10)		(16)	(20)		(32)	(40)		(64)	(80)		(125)	(160)		(250)	(320)		(500)	(650)		(1000)	(1250)		(2000)	(2500)		(4000)	(5000)		(8000)	(10000)	

There isn't room on the small film-speed control to show numbers for each possible setting. The dial is numbered for the standard series of ASA numbers. Between the standard ASA numbers are dots representing other film speeds as shown by the numbers in parentheses in the table.

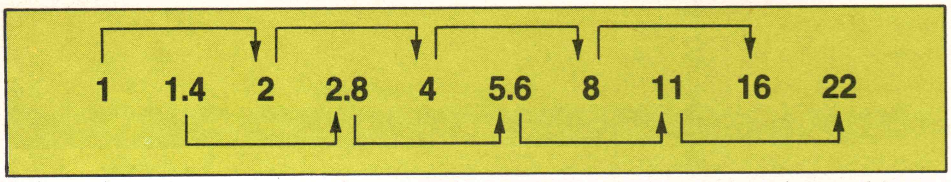
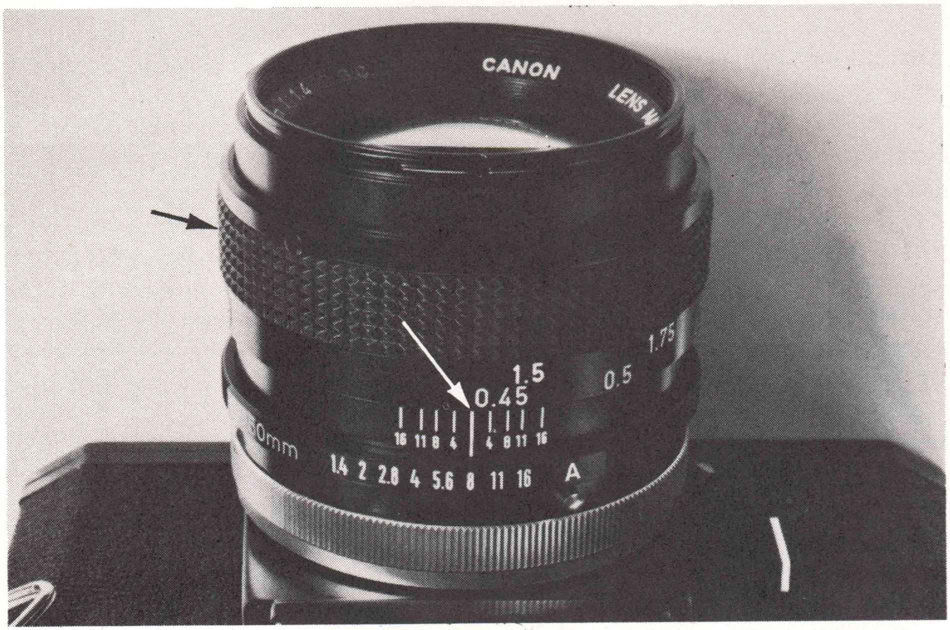


Figure 3-1/It's easy to write or remember the *f*-number series by starting with two numbers, 1 and 1.4. Begin with those two numbers and double them alternately as shown.



The aperture-control ring rotates to select aperture size. Markings on this ring show it has a maximum aperture of *f*-1.4 and a minimum aperture size of *f*-16. The aperture setting is read against an index mark on the lens barrel shown by the white arrow. This lens is set for *f*-8. The letter A and adjacent pushbutton are used to set the lens for automatic operation. The lens is focused by rotating the knurled ring (black arrow) near the front.

more or less light on the film became known as changing *stops.*

The word remains with us; *f*-numbers are often called *f*-stops and changing the *f*-number setting of a lens to allow more or less light on the film is often called *stopping up* or *stopping down.*

Changing from *f*-22 to *f*-16, the nearest larger opening, is called changing by one stop. Earlier I defined doubling the amount of light as an exposure change of one *step.* You can conclude that the words *step* and *stop* mean the same thing in photography. I prefer to use *step* to mean doubling or halving exposure and international standards for the photographic industry use *step* rather than *stop.* Popular literature and most books cling to *stop* and we will probably never eliminate it from our vocabularies.

ASA OR DIN?—The ASA method of stating film speed was developed in the United States. The DIN system was developed in Germany. They are two different ways of giving the same information about film. In the ASA system, each step is *double* the next lower value. In the DIN system, the steps mean the same thing, but are obtained by *adding* **3** units to get the next higher number.

The two speed-numbering systems agree at 12 and then follow their individual patterns for higher and lower speeds:

ASA	6	12	25	50	100	200	400	. . .
DIN	9	12	15	18	21	24	27	. . .

With either system, higher speed numbers mean the film is more sensitive and, therefore, requires less exposure.

Setting the Aperture Ring—The aperture-control ring has click-stops, or detents, at full *f*-stops along its range. Halfway between marked detents are unmarked detents which are half-stops. The detent between *f*-4 and *f*-5.6 for example, is a half-stop higher than *f*-4 and a half-stop lower than *f*-5.6. When using the aperture-control ring to balance the exposure display, you can set it at *any position* whether exactly on a detent or not.

THE SHUTTER-SPEED SERIES

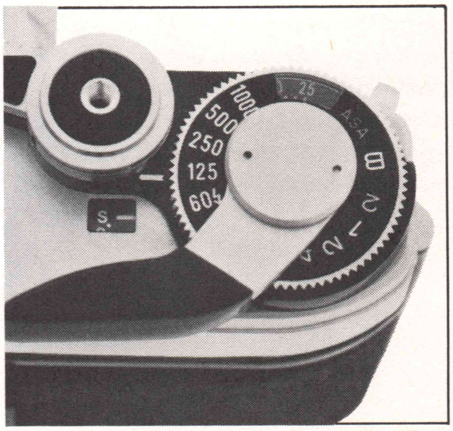
Shutter speeds also change in steps so each longer time is double the preceding step. The standard series of shutter-open times in seconds is:

1 1/2 1/4 1/8 1/15 1/30 1/60
1/125 1/500 1/1,000 1/2,000

For simplicity and ease of reading, the shutter-speed dial does not show the numerator of the shutter opening-time fraction. Instead, **125** is used to mean 1/125 second, **500** means 1/500 second, and so forth.

The shutter speed series is *intended* to double as it goes from shorter to longer times. There are some approximations such as between 1/125 and 1/60 but they are not important. You should also learn this series of numbers, and it is easy to do.

You cannot select any in-between shutter speeds. Only the exact marked speeds can be used.



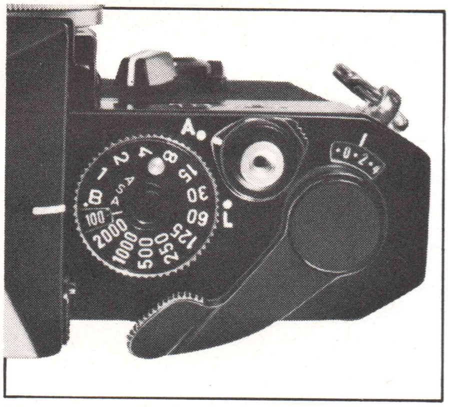
This AE-1 camera is set for ASA 25 as you can see in the window on the shutter-speed dial. Shutter-speed setting is 1/125 second. Range of shutter speeds is from 1/1000 to 2 seconds, plus B which is discussed on following page.

Just below the slowest timed shutter speed on the dial is the symbol **B** which we say stands for *bulb.*

The **B** setting is used for exposures longer than the shutter mechanism will perform automatically. When set at **B** the shutter will remain open as long as you hold the shutter-release button depressed. On all Canon cameras you can transfer the burden from your finger to a locking cable release for long time exposures. The cable release screws into the top of the shutter button and allows you to operate the shutter remotely by a plunger at the far end of the cable. Locking cable releases have a set screw or locking arrangement to keep the plunger depressed when you want a long exposure.

The FTb and F-1 models have a mechanical locking lever surrounding the button itself. You can open the shutter on **B**, flip the lock lever to **L**, and the shutter will stay open until you release the lock.

A-series cameras have a shutter-lock lever on a ring surrounding the shutter-release button. However it can only be locked to prevent accidental shutter release. Once the shutter button has been operated, you cannot then turn the lock lever to hold the shutter open. You can do it with a locking cable release.



When the shutter-speed selector is set at B, the shutter will remain open as long as the shutter button is held down.

Some cameras have a Shutter Lock Lever which surrounds the shutter button. If the control is set to L, the shutter button cannot be depressed. Set the control to A and the button can be operated. To use a shutter-release cable, screw it into the threaded hole in top of the shutter button. Cable release will work in either position of the lock lever.

VIEWFINDER DISPLAYS

A good attitude to take about viewfinder displays which help you set exposure is: They recommend or suggest the camera-control settings you should use to get the standard amount of exposure requested by ASA film speed. You don't have to use those settings and you may choose to use some other pair of settings. The camera allows you to take charge and do whatever you choose. In most cases the camera-recommended control settings will be correct.

Figure 3-2 shows one type of Canon viewfinder display, called match-needle.

There are two other types of viewfinder displays in Canon cameras. Figure 3-3 shows the AE-1 display for automatic operation. After you choose a shutter speed, the AE-1 sets aperture size automatically, depending on the amount of light from the scene. The viewfinder display is a moving needle that shows you what aperture the camera is selecting.

Figure 3-4 is the display you see when using the A-1 camera. This camera can be set to operate six different ways—two of them discussed here. The display is letters and numbers, called *alphanumeric,* below the image area in the viewfinder. It shows shutter speed on the left and aperture size on the right.

If you have the A-1 set so *you choose shutter speed,* the shutter-speed readout shows the speed you selected. The aperture-size readout shows which aperture the camera has selected automatically, and changes if the light on the scene changes.

If you have the A-1 set so *you choose aperture,* the aperture display shows the *f*-number you selected. Shutter-speed is automatically controlled by the camera and the shutter-speed display shows you which speed the camera has selected.

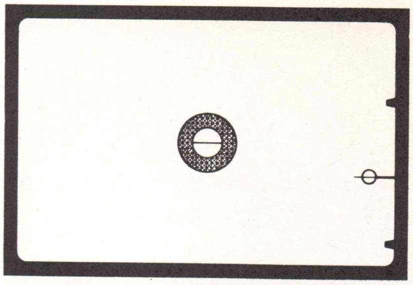


Figure 3-2/In a match-needle display, both needles move with changes in the light and camera control settings. When the two needles align so the Meter Needle passes through the circle on the end of the Aperture Needle, exposure will be correct for an average scene.

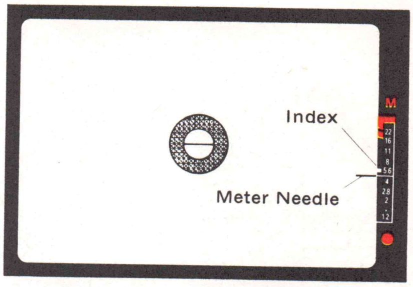


Figure 3-3/On the right side of the AE-1 image area in the viewfinder, a moving needle indicates the lens aperture size the camera is selecting automatically. On non-automatic operation, the needle shows the aperture seeting the camera "thinks" you should use.

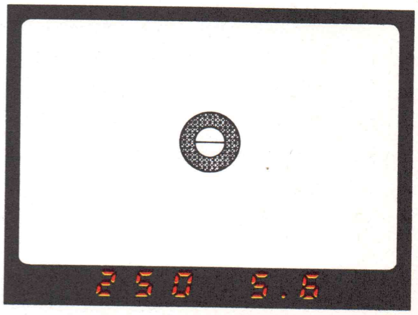


Figure 3-4/In the A-1 viewfinder image area, all you see is the scene plus faint circles in the center which help you focus. Camera settings are in red "computer letters" below image. Number at left is shutter speed, at right is lens aperture setting. Exposure will be correct for an average scene unless the viewfinder display gives you a warning by flashing one of the readouts.

4

HOW A SINGLE-LENS-REFLEX CAMERA WORKS

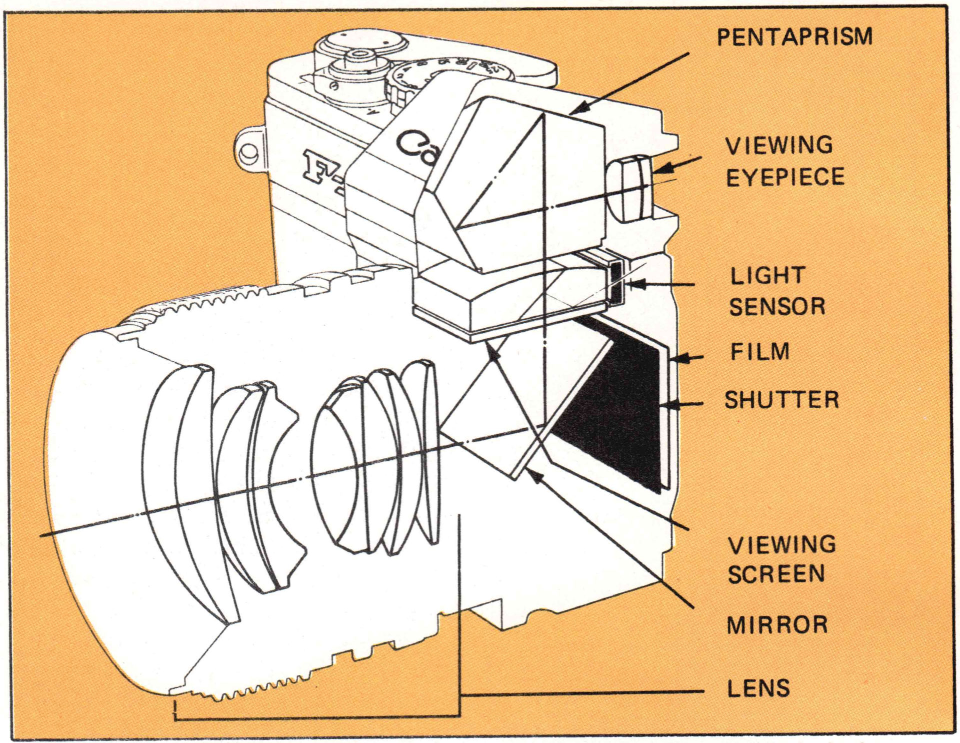


Figure 4-1/When viewing the scene with an SLR, the light path is: Through the lens to the mirror which is in the down position; straight up from the mirror due to reflection; multiple bounces in the *pentaprism* so you see an upright correctly-oriented image in the viewfinder. Between the mirror and the pentaprism is the viewing screen which captures the same image that will later fall on the film. In some camera models, a cadmium-sulfide (CdS) light sensor for exposure measurement is adjacent to the viewing screen as shown. Other models have the light sensor near the viewing eyepiece.

The main feature of a single-lens-reflex (SLR) camera which distinguishes it from other types is: You view and focus through the same lens used to cast the image onto the film. This has several important advantages and some relatively minor disadvantages.

The word *reflex* is a form of the word *reflection* and indicates that the image you see in the viewfinder is bounced off a mirror in the optical path between the lens and your eye.

Single-lens-reflex cameras are designed as shown in Figure 4-1. The lens captures light from the subject being photographed. A focusing control, moves the lens closer to or farther away from the film.

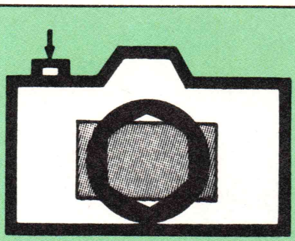
To view, a mirror is moved to the "down" position to intercept light traveling from the lens toward the film. This intercepted light is bounced upward by the mirror to a viewing screen and then through a special prism so it finally emerges at the viewing window where you can see what is coming in through the lens. You get the same view the film will get when you take the picture.

The *pentaprism* not only reflects the light rays internally so they come out the viewing window, it also causes the image you see to be correctly oriented—top to bottom and left to right. Like wealth, it's easy not to appreciate the benefit of correct viewing until you have to do without it.

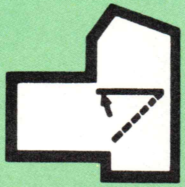
The viewing screen is just below the pentaprism. The camera is built so the distance from lens to viewing screen by way of the mirror is the same as the distance from lens to the film in the back of the camera. Therefore, if the image is in focus as you see it on the viewing screen it will later be in focus on the film when the mirror is moved out of the way to take a picture.

A convenient way to think about it is this: You look through the pentaprism to examine the viewing screen which is showing you the image that will fall on the film when you trip the shutter. If you like what you see, squeeze the shutter button and several things happen very quickly.

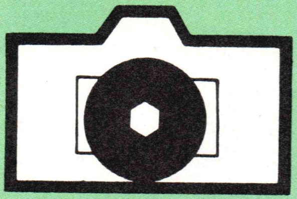
The mirror moves up out of the way. As it swings up to its parking place you lose your view of the image. When the mirror is out of the way, the focal-plane shutter in



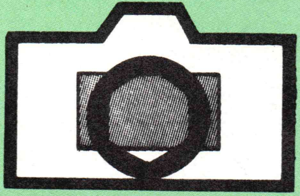
While viewing and composing the picture, lens aperture is wide open, shutter is closed, mirror is down. Dark rectangle represents closed shutter. Depress the shutter button and . . .



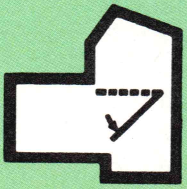
Mirror moves up so light can travel from lens to film . . .



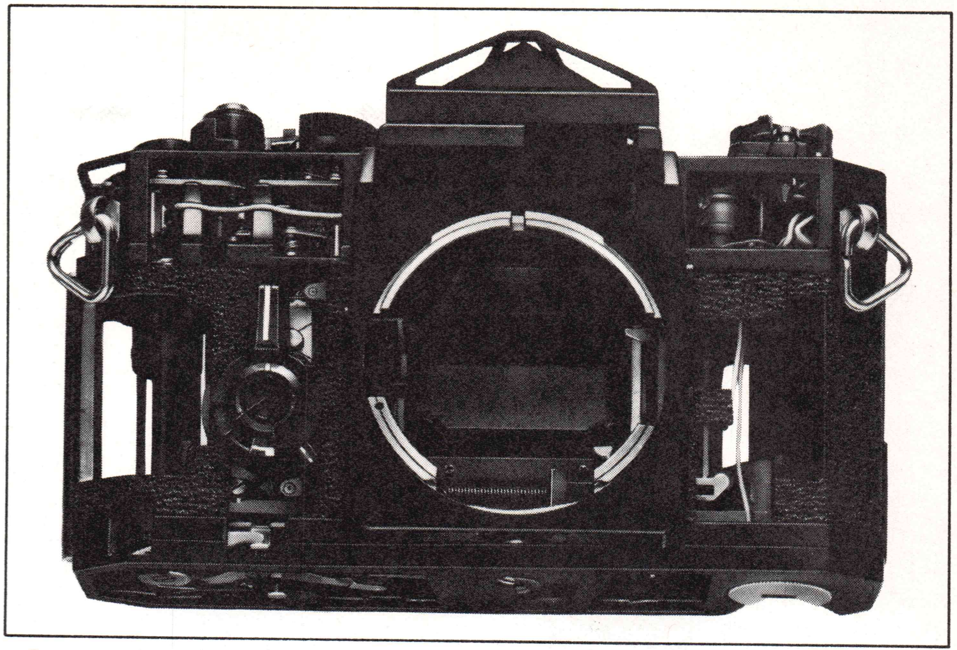
Lens aperture closes to selected aperture size for correct exposure, *then* shutter opens for selected length of time . . .



Then shutter closes and lens aperture returns to wide open so you can view again with maximum scene brightness and . . .



Instant-return mirror swings to down position, ready for next shot. Operate the Film-advance lever to bring the next frame of film into shooting position.



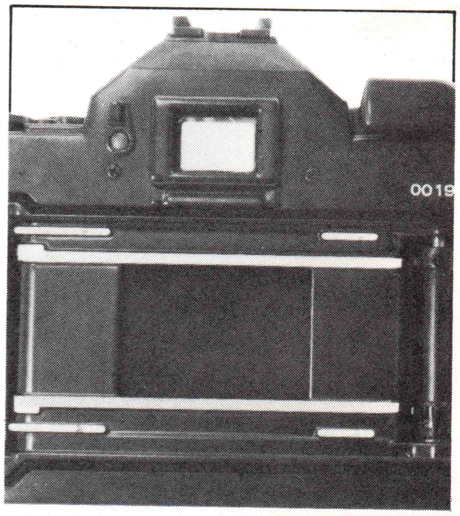
Cutaway view of the F-1 shows some of the mechanism and the mirror in the down position. Above the mirror you can see part of the focusing screen. One feature of this model is interchangeable focusing screens—each designed for a particular photographic situation.

front of the film is moved so light from the lens falls on the film. When the desired amount of time for film exposure has passed, the shutter closes.

The mirror automatically swings back down to the viewing position. Even though you lose sight of the scene while the film is being exposed, this time is usually brief and you quickly learn to ignore the "blackout." It's as if the camera "blinked."

In addition to mirror movement in synchronism with operation of the focal-plane shutter, the busy camera mechanism also lets you view the scene through the widest possible lens aperture for maximum scene brightness in the viewfinder. When you press the shutter button, the camera automatically closes lens aperture to the *f*-stop you previously selected when balancing the viewfinder exposure display. For example, if the needles match when you have selected *f*-11 with the control ring on the lens, the lens will automatically close down to *f*-11 after you depress the shutter button.

With all that done and the image captured on one frame of the film, use the film-advance lever to move the next frame of film into position for the next picture. The advance lever also winds up the camera mechanism so it can operate mirror, lens aperture and shutter for the next exposure.



Rectangular opening in camera body determines size and shape of frame on film. This opening is usually closed by the focal-plane shutter as shown here. Film travels along metal guide rails behind focal plane shutter, from left to right in this view. Film is not loaded in this camera and the back cover is open so you can see inside.

5

HOW A FOCAL-PLANE SHUTTER WORKS

Focal-plane shutters are mounted in the camera body very close to the surface of the film. Focal-plane shutters are virtually standard on SLR cameras, including all Canon SLR's.

The basic idea is illustrated in Figure 5-1. Two curtains are mounted on rollers. One, called the *first curtain,* is opaque except for a window in the curtain which is larger than the frame of film to be exposed. Normally, the first curtain is positioned so it covers up the surface of the film and does not allow light to reach it.

To make an exposure, the first curtain travels from one roller to the other. The window in the first curtain moves across the film frame and stops at a location which leaves the frame open to receive light from the lens.

When the desired time of exposure is ended, the *second curtain* is released. This curtain is completely opaque, with no opening. The second curtain moves from roller to roller and covers up both the window in the first curtain and the film frame which has been receiving exposure. Exposure is completed.

Exposure time is measured from *release* of the first curtain to *release* of the second curtain. For a relatively long exposure time such as one second, the first curtain has time to reach the end of its travel before the second curtain starts to move. There is a period when neither curtain is moving and the entire film frame is uncovered and exposed to light from the lens.

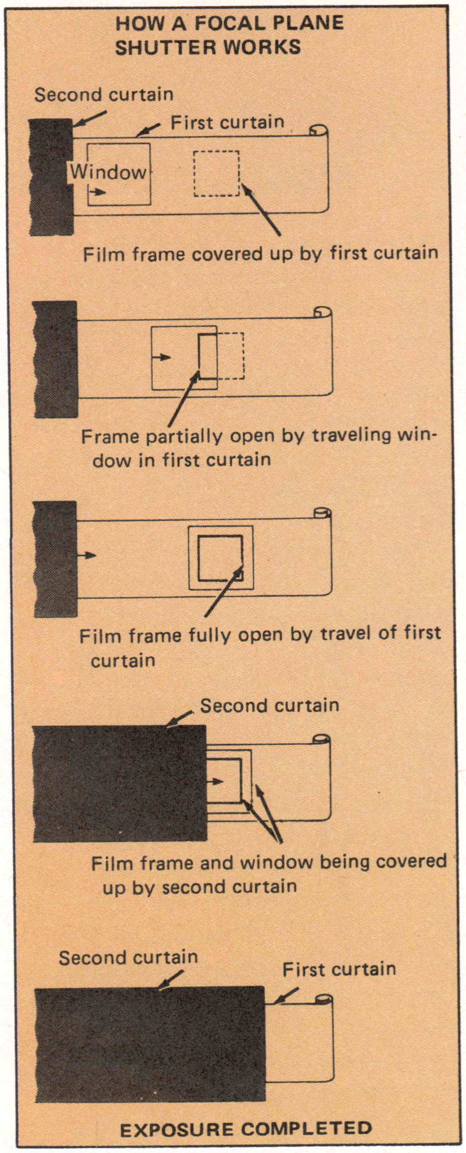
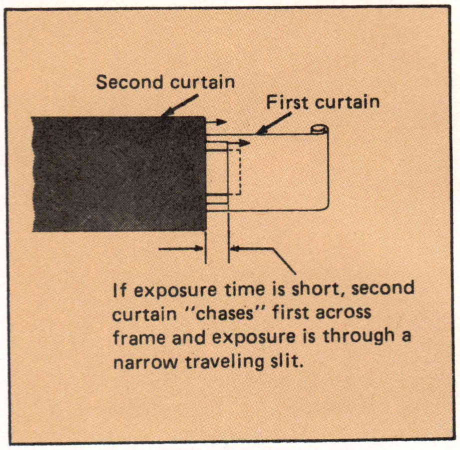

HOW A FOCAL PLANE SHUTTER WORKS
Second curtain
First curtain
Window
Film frame covered up by first curtain
Frame partially open by traveling window in first curtain
Film frame fully open by travel of first curtain
Second curtain
Film frame and window being covered up by second curtain
Second curtain
First curtain
EXPOSURE COMPLETED

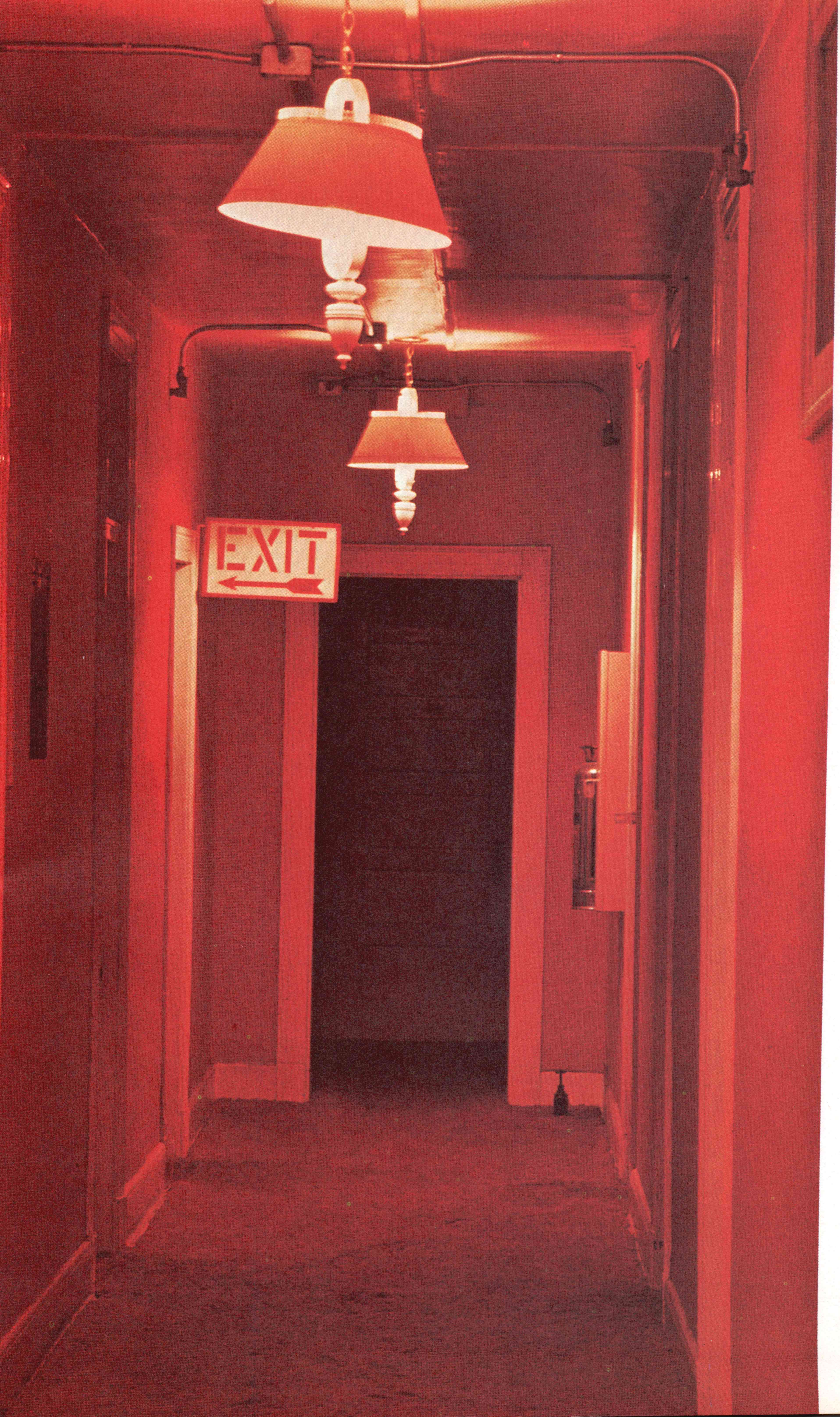
Figure 5-1/Operation of a two-curtain focal-plane shutter which travels horizontally. This shows a long exposure time during which the window in the first curtain completely opens up the frame before the opaque second curtain is released to cover up the frame.


Second curtain
First curtain
If exposure time is short, second curtain "chases" first across frame and exposure is through a narrow traveling slit.

For short exposures such as 1/500 second, the second curtain follows so closely behind the first curtain that the entire film frame is never open to light all at the same time. The frame is exposed by a traveling slit of light formed by the narrow gap between the two curtains.

For a very short exposure time such as 1/500 second, the first curtain will not have traveled very far before the second curtain starts chasing it across the frame. The film frame will be exposed by a narrow traveling slit of light formed by the gap between the two curtains. At no time is the complete film frame ever exposed all at once to light from the lens. For most picture-taking situations, it doesn't matter that the frame was exposed by a traveling slit of light. In Chapter 15, you'll see that it does matter when you are using electronic flash.

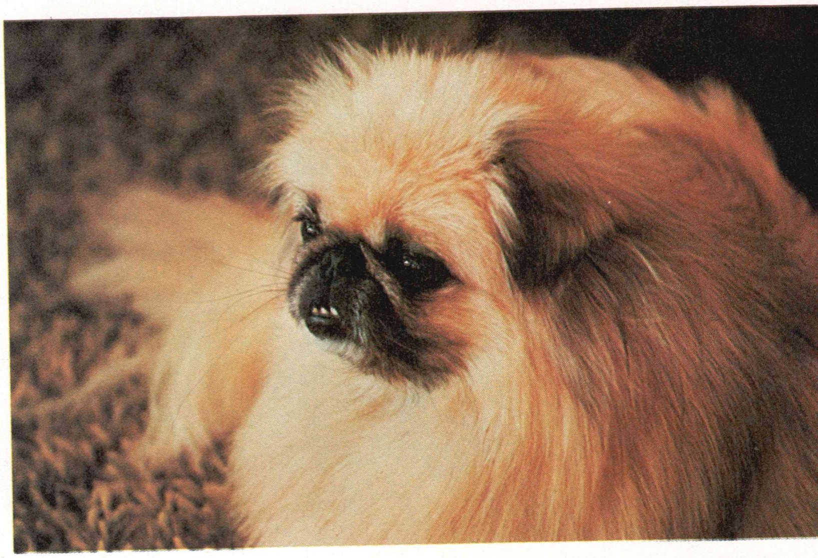
In most Canon SLR cameras, the focal-plane shutter travels horizontally—meaning across the long dimension of the frame. Among cameras discussed in this book, the only exception is the EF which has a shutter with curtains which travel vertically.



Shutter speed set to 30 seconds. Aperture set automatically by camera.

6

GETTING ACQUAINTED WITH LENSES



An important feature of Canon SLR cameras is interchangeable lenses. Canon offers more than 40 different lenses which can be used on any Canon camera. Some are designed to capture a distant subject and record it on film as though it was only a short distance away. Others are designed for close-up photography, to make a relatively large image of a very small subject. Between these extremes are lenses for ordinary applications and several special types including zoom lenses and a lens for shooting architecture. Available Canon lenses are described in Chapter 14.

Among this variety of lenses, there are two basic types differing in the operational details of how light metering is accomplished. The two lens types are called FL and FD lenses. All current Canon cameras can use both types of lenses.

When you look into the viewfinder, preparing to take a picture, you focus on the scene and compose the picture you intend to take. To get the right composition, you may change the location of the camera, change lenses, or try different focal lengths of a zoom lens to see which gives the most pleasing image. Then you take an exposure reading of the scene, using the camera's built-in light meter, and set the camera exposure controls. Generally these two procedures are called *viewing* and *metering.*

Photography is more successful and more fun with lenses for different shooting situations. Photo of the seagull was made with a 200mm lens, the Pekingese with a 50mm, and the grasshopper with a close-up supplementary lens described in Chapter 10.

For viewing it is usually best to keep lens aperture wide open because that gives the brightest image on the viewing screen in the viewfinder. With lenses that have no automatic features, you can open lens aperture *manually* by turning the aperture-control ring on the lens. Then, after viewing, you manually close down lens aperture for correct exposure. The aperture you use to make the exposure is sometimes called *shooting aperture.*

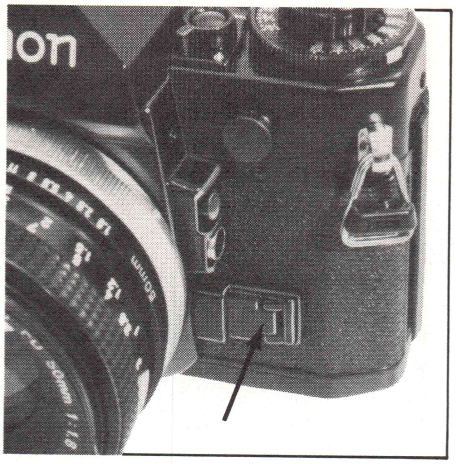
FL Lenses—An improvement over manual aperture control uses a lever in the camera to operate a lever on the back of the lens. Working together, these levers provide a feature called *automatic aperture*. It does what I mentioned earlier: The lens remains wide open until the moment of exposure and then the levers close down the lens to shooting aperture. Of course you must measure the light some way and set the aperture you intend to use.

In 1964, Canon announced a new series of lenses with the lever on the back for automatic aperture and called them FL lenses.

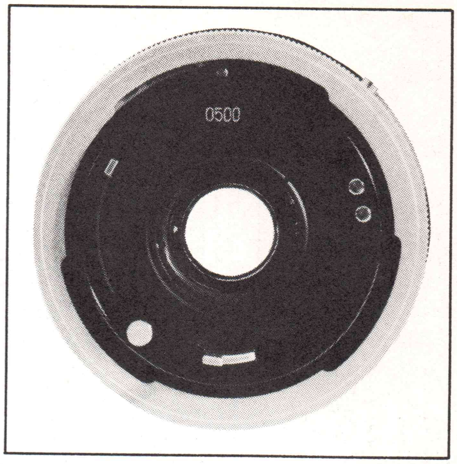
Stop-Down Metering—A big advantage of modern SLR cameras is that they use a built-in meter to measure light from the scene *after* it has come through the lens. This eliminates the necessity for separate accessory light meters and makes camera adjustments much simpler. When using FL lenses and lenses that require manual aperture control, you can't measure the light coming through the lens with the aperture wide open because it won't be the same as the amount of light that comes through later, at shooting aperture.

With these lenses, you must stop down to shooting aperture while you take the exposure reading. The camera light meter measures the actual amount of light that will be used to make the exposure. This is called *stop-down* metering. You view and focus at *full aperture* and then stop down to perform metering.

FD Lenses—Introduced in 1971 and still the standard Canon lens design, FD lenses have additional levers and pins on the back. I won't discuss them specifically until Chapter 10. For now, I just want to tell you what the lens does. FD lenses allow you to take an exposure measurement at wide-open aperture, after composing and focusing. This is called *full-aperture* metering.



A-series cameras have a Stop-Down Lever (arrow) in this location. Push it toward the lens to stop down to shooting aperture as selected by the lens aperture-control ring. There are special procedures for metering stopped down with A-series cameras—described later in this book.



The Canon Breech-Lock lens is attached by the knurled metal ring at the back of the lens. The three cutouts on the ring fit over three mating projections on the camera body. The Breech-Lock Ring is then rotated to clamp the lens onto the camera body. The pins and levers on the back of the lens work mechanically with mating parts in the camera.

Because you normally shoot at a smaller aperture than wide open, full-aperture metering requires cooperation between lens and camera body so the lens "knows" what the shooting aperture will be.

Except for the automatic cameras, here's how it works: Focus and compose the image with the lens wide open. Then adjust shutter speed and lens aperture until the exposure indicator in the viewfinder display indicates "correct exposure" as shown on page 13.

Even though you turn the aperture-control ring and the viewfinder exposure indicator responds to the changes, lens aperture remains wide open and the viewfinder image remains at maximum brightness. A mechanical linkage on the back of the lens "tells" the camera what *f*-number you have selected. The light meter in the camera *measures* at full aperture but *anticipates* the reduction in light coming through the lens when it stops down to shooting aperture. This simplifies using the camera and is very convenient.

FD lenses allow *both* full-aperture viewing and full-aperture metering. These automatic features depend on mechanical linkages between lens and camera body. Some accessories fit between lens and camera but do not make the mechanical connections so the camera "knows" what is happening at the lens. When using these accessories, you must meter stopped-down even with an FD lens. These accessories are used to get higher image magnification and are discussed in Chapter 13.

With some exceptions I'll get to later, FD lenses work the same way on automatic cameras. When the camera is choosing lens aperture after you set shutter speed, the camera first measures the light at full aperture, then it decides what the shooting aperture should be, then it sets shooting aperture just before the exposure.

LENS MOUNT

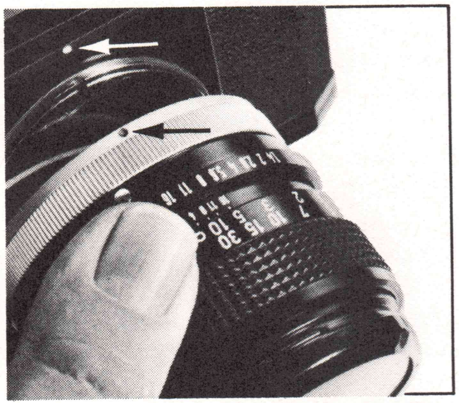
Canon lenses mount with a breech-lock mechanism in which the critical surfaces that locate the lens on the camera never rub against each other. Therefore wear is minimal.

The mounting surface of the lens is pressed against a mounting surface on the front of the camera—without any turning or sliding friction between the surfaces. A separate Breech-Lock Ring on the back of the lens has three projections which mate with three similar projections on the camera. Turning the Breech-Lock Ring on the lens causes these projections to work against each other like screw threads. This *clamps* the mounting surface of the lens against the mounting surface on the camera.

If the projections on the Breech-Lock Ring or camera mount develop wear, it only means that the ring must be rotated a little farther to clamp lens to camera. The threads on the clamping ring do not participate in locating the lens, they only hold it against the locating surfaces.

The diameter of the Canon mount is relatively large which gives rigidity. It also gives a lot of room on the back of the lens which is used for camera automation by pins and levers.

If you look at any Canon SLR lens, you will see there is plenty of room for these parts—in fact one space on the lens mount is reserved for an unspecified improvement of future lenses.


To mount a Canon lens, first be sure the Breech-Lock Ring is turned fully counterclockwise as viewed from the front. Lenses of recent manufacture lock in that position when removed from the camera but early lenses do not. Align dot on Breech-Lock Ring (black arrow) with similar dot on camera body above lens mount (white arrow). Press lens against camera body and rotate Breech-Lock Ring clockwise.

When mounting a lens, it's not necessary to use great force when tightening the Breech-Lock Ring. Turn it until it is tight, but don't force it.

The Canon Breech-Lock lens mount is an outstanding design because: Wear at the mounting surface is eliminated, therefore the lens-to-film distance never changes. The mount is large and stable. There is plenty of room for mechanical linkages and signaling devices between lens and camera body. Because the lens is precisely located onto the camera and because the lens itself is never rotated to install it, alignment between signal pins and levers on lens and on camera is near-perfect.

LENS IDENTIFICATION

The standard lens that comes with most Canon SLR cameras is an FD 50mm *f*-1.8 S.C. In that designation, *50mm* is the *focal length* of the lens, and *f*-1.8 is the largest aperture which can be selected.

The prefix FD means the lens has the automatic feature which allows full-aperture metering.

The letters S.C. stand for Spectra Coating, a single-layer lens coating to reduce flare when shooting into the light. Some Canon lenses are labeled S.S.C. for Super Spectra Coating which is multi-layer.

The basic specifications of a lens are focal length and *f*-number.

EFFECT OF FOCAL LENGTH

Focal length is expressed in millimeters, abbreviated *mm.* Technically, focal length is the distance between a certain location in the lens and the film in the camera, when the lens is focused at infinity.

One practical value of focal length is a label or name for different types of lenses. The focal-length number tells you what the lens will do on the camera.

Lenses are grouped by focal length into three classes: short, medium and long, according to this table:

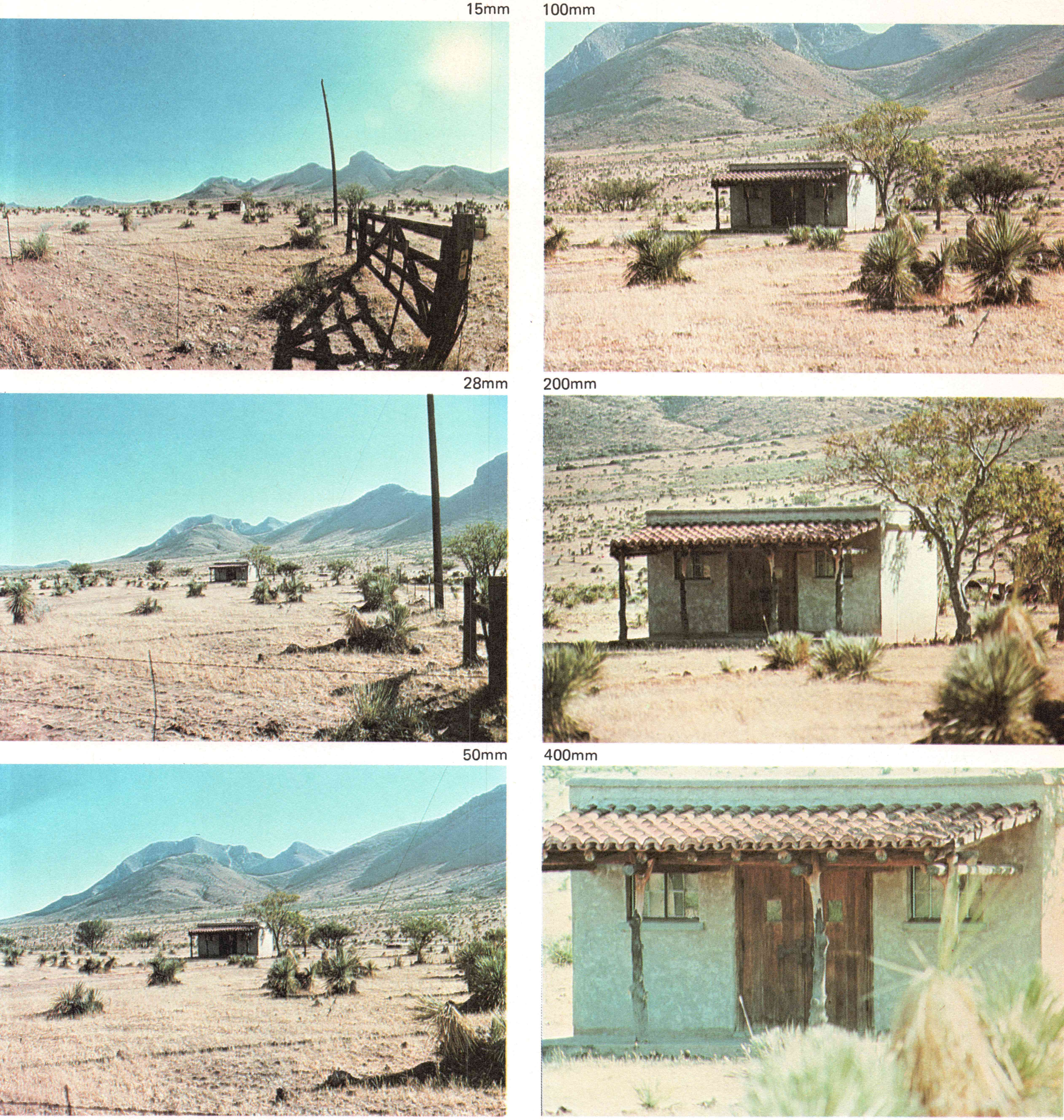
Short focal lengths—
35mm and shorter
Medium focal lengths—
45mm to 85mm
Long focal lengths—
100mm and longer

The differences are *angle of view* and *magnification.* Short-focal-length lenses such as 20mm and 28mm have wide angles of view and

SQUEEZE THE SHUTTER BUTTON—
Jiggling the camera at the moment of exposure probably spoils more pictures than any other cause. The human body is a very unstable mount for a camera. With a long lens, you can see the scene move with each of your heartbeats. The scene isn't moving—you are!

Learn to take a relaxed stance so your muscles don't quiver under stress or tension while you are getting ready to shoot. Hold the camera steady and well braced with both hands, using your forehead and cheek for additional steadiness. Take a breath, let half of it out, then hold your breath while you take the picture.

Even after doing all that, if you push or jerk the shutter button, the camera will be in motion at exactly the wrong instant. Learn to *squeeze* the shutter button so you don't move the camera. Practice helps.



15mm

100mm

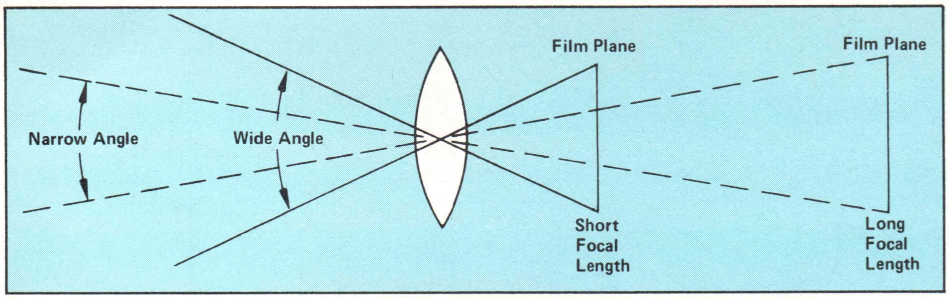
28mm

200mm

50mm

400mm

This series of photos shows the pictorial effect of different angles of view. Camera location was not changed while the scene was photographed with various lenses ranging from a 15mm fisheye lens to a 400mm. When camera location is not changed, the *only effect* of different focal lengths is greater magnification at smaller angles of view. The view and perspective of the cabin in the 400mm shot is *exactly the same* as any of the other shots if the other pictures were enlarged to make the cabin the same size. There is some fisheye distortion in the 15mm shot which makes the power pole curve.



Angle of view is the angle between the outermost light rays which can enter the lens and form an image at the film plane. Short focal-length lenses have wide angles of view, long lenses have narrow viewing angles.

low magnification. Let's discuss these one at a time.

Angle of view, as shown in the drawing above, is the angle between the two edges of the field of view. It varies with focal length.

The angle of view is that angle which covers the diagonal of the film frame.

Use wide-angle lenses when you want to show a lot of the scene being photographed. They are handy in taking interiors when you want to get a lot of the room and the walls prevent you from backing up very far.

You can get a feel for angle of view by testing your own vision. With both eyes open, hold your arms straight out to the sides and then move them forward until you can just see your hands while looking straight ahead. The angle will be less than 180 degrees.

Do it again with one eye closed. The angle will be a lot less. Clear vision for a single eye covers a total angle of around 50 degrees or so, depending on where you decide you can't see clearly enough to call it vision.

A 50mm lens has an angle of view of about 46 degrees. This is often called a *normal* lens for 35mm cameras and the reason given is the angle of view is about the same as the human eye. For this to be true you have to go around with one eye closed or inoperative.

I prefer to consider a 50mm lens as *standard* for 35mm cameras rather than *normal* because it is a good general-purpose lens and a compromise between wide and narrow angles of view. You can't do everything with a 50mm lens, but you can make a lot of fine pictures with it.

Long lenses such as 200mm and 300mm have narrow angles of view. A 200mm lens has an angle of about 12 degrees. A common type of lens with long focal length is called *telephoto.* Not all long lenses are of the telephoto design but most are and the word has come to mean the same thing as a long lens in popular terms.

We think of a long lens as one that can "reach" way out and fill the frame with a distant subject such as a mountain climber high up on a rock face. It excludes most of the mountain because of its narrow angle of view. What that really means is the lens has high *magnification.*

Magnification is the size of the image on the negative divided by the size of the subject. Canon technical literature uses the term *reproduction ratio* to mean image size divided by subject size. It is typically stated as a proportion such as 1:5, where the colon between the numbers means *divided by.*

A reproduction ratio of 1:5 says the image is one unit tall and the subject is 5 units tall. The unit of measurement can be inches or centimeters.

If you perform the indicated division, 1 divided by 5, you get 0.2 which I call *magnification.* In other words, a reproduction ratio of 1:5 and a magnification of 0.2 mean the same thing.

One frame on a 35mm negative is 24mm tall by 36mm wide, which is about one by 1.5 inches.

If you photograph a six-foot (72 inch) person so he fills the one-inch dimension of the frame then the magnification is one-inch divided by 72 inches or 1/72. That isn't much. It is less than one, meaning the image is smaller than the real-world subject—in fact it is only 1/72 as tall.

From a practical standpoint, if you want to make an image larger on the film you have two choices: Move the camera closer to the subject or use a longer-focal-length lens with more magnification.

An obvious advantage of an SLR camera is: You look through the lens which will take the picture so you can see angle of view and magnification. When you own more than one lens and become familiar with what they do, you will almost automatically select a lens for each different picture-taking situation.

ZOOM LENSES

A special type of lens called *zoom* changes focal length by a control on the lens. One Canon zoom lens lets you use any focal length from 100mm up to 200mm. If you want the subject to fill the frame, zoom until it does. Then adjust the exposure controls on the camera and shoot the picture.

MAXIMUM APERTURE

Lenses are specified according to the smallest *f*-number which can be selected—*the largest aperture.*

With Canon cameras, one standard lens is 50mm, *f*-1.8. For more money you can get *f*-1.4, or an *f*-1.2 lens. More expensive lenses have Super Spectra Coating which accounts for some of the additional cost, but even with the same coating, lenses with larger aperture cost more.

Larger-aperture lenses are sometimes called "faster" because they let in more light and therefore make the exposure in a shorter time.

Some photographers like to shoot in *available light,* meaning whatever amount and type of light they find. Often *available light* also means *dim light* such as inside buildings, barns, factories, and at twilight. If you enjoy shooting with the realism of available light, the *f*-1.4 lens is better for you than the *f*-1.8. Choose the *f*-1.2 if the cost is not too much for your budget.

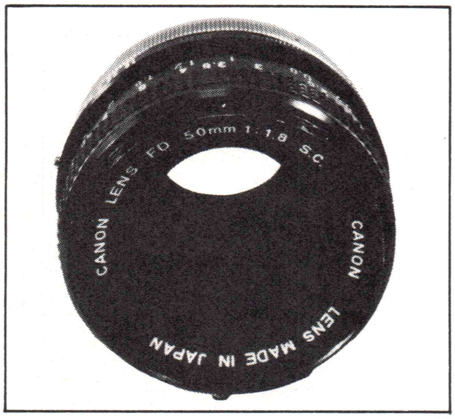
A peculiarity of lens nomenclature is that aperture is indicated in two ways. The aperture-control ring shows *f*-numbers such as 1.4 and 2.8.

On the front of most lenses, engraved on the ring surrounding the glass, is the manufacturer's name, lens identification for that lens, a serial number, focal length in millimeters, and a symbol such as 1:1.4, called *aperture ratio.*

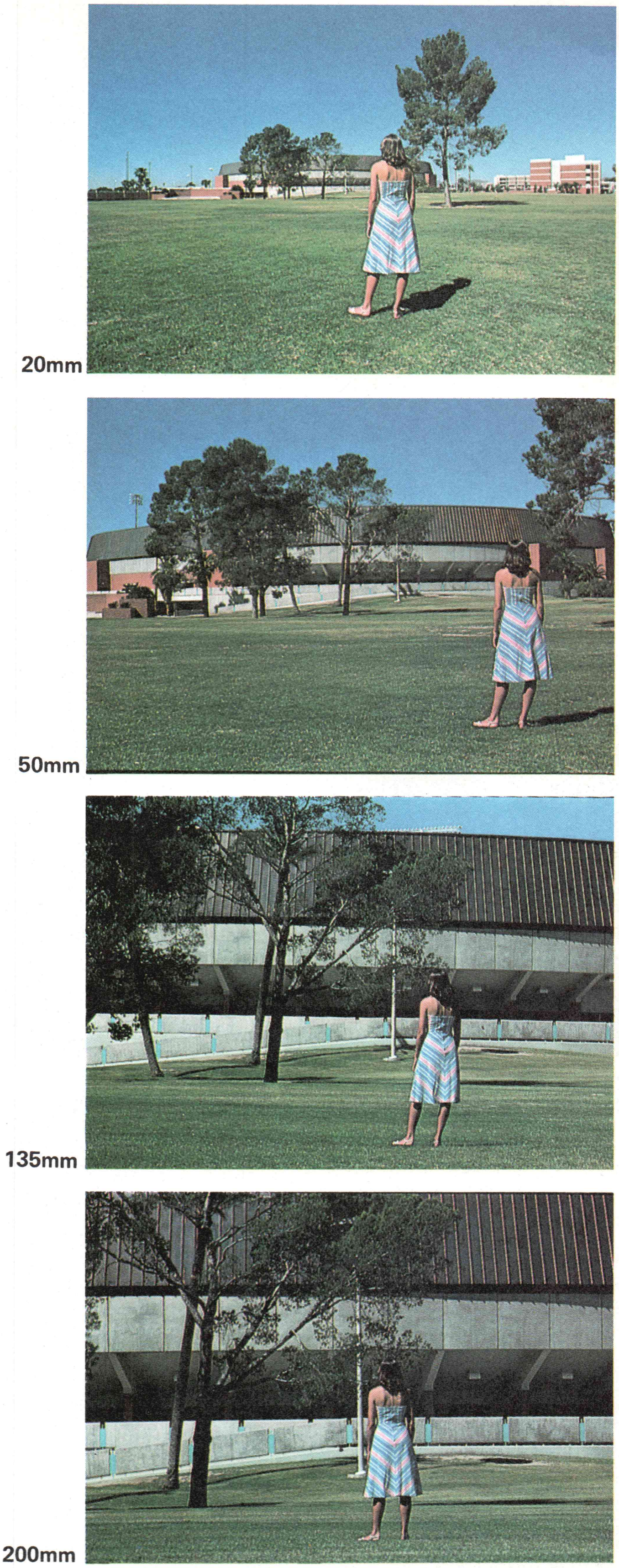
You can ignore the first 1 in the aperture-ratio designation. The 1.4 part is the maximum lens aperture, stated as an *f*-number.

In other words, if you are buying a lens marked 1:1.8, it's an *f*-1.8 lens.

There are several common ways of writing *f*-numbers in publications such as *f*-4, *f*/4 and *f*:4. Canon uses *f*/4. Because this book is part of H. P. Books' series on photography and we had already settled on *f*-4 as our standard way of writing it, we use *f*-4 where Canon uses *f*/4.



Lenses are identified by markings on the front. This is an FD lens, 50mm focal length, maximum aperture of *f*-1.8 with Spectra Coating.



If the camera location is changed, perspective is changed. This scene shot with four different focal lengths, moving the camera each time so model was the same size in the viewfinder.

7

FILM HANDLING

The characteristics of photographic emulsion change slowly after manufacture in two principal ways. Old film shows an overall density, called *fog,* after development which can not be accounted for by exposure to light. It is a deterioration of the silver halide in the emulsion.

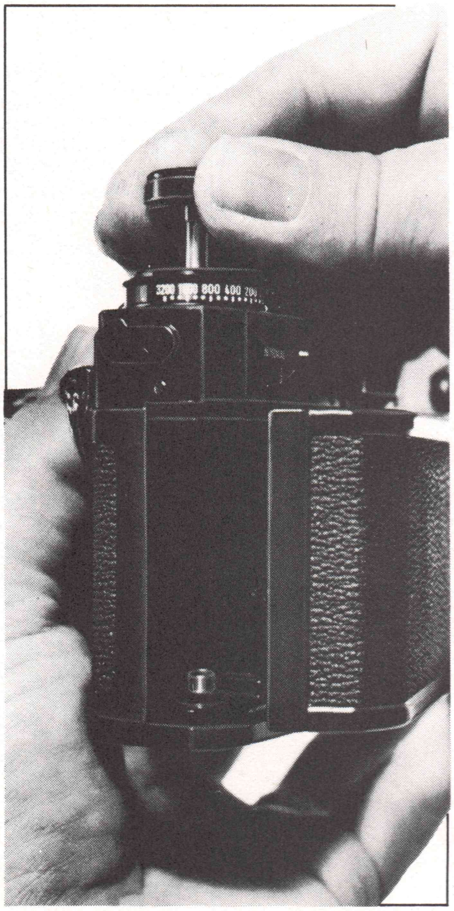
The density range which the film can produce is limited by this because areas on the film which should be clear are fogged instead. Also, the difference in tone between two objects in the picture will be less on old film than fresh film. This difference is called *contrast* and lack of it causes prints to look "flat." They have an overall gray appearance instead of strong blacks and vivid whites with definite visible differences between the image tones.

With color film, the image recorded by silver halide in the emulsion is converted during processing to appear in color. Changes in the photographic emulsion due to aging affect the colors in the final transparency or color print in ways difficult or impossible to correct.

Commercially packaged films carry a date on the carton referred to as the *expiration date* even though nothing drastic actually happens at that instant. Although film should be exposed and processed before that date, the film will probably be about as good during the month after its expiration as during the month before. The date means the film should perform satisfactorily up to that time under normal conditions of storage.

Expiration dating of films intended for amateur use is based on storage at room temperatures comfortable for people—around 70 degrees Fahrenheit (21°C.) and around 50% relative humidity.

Higher temperature and higher humidity accelerate the aging process and humidity is the worst culprit. Most commercially packaged film is sealed in a pouch or can to protect the film from external humidity changes. If the emulsion dries out excessively, that's not good either.



To load film, open the camera back by pulling up on the rewind knob. All Canon SLRs open the same way.

Storing film at reduced temperatures—such as in your refrigerator—slows down the aging process, and is recommended both before and after exposure if you hold the film a long time before shooting or a long time after shooting and before development. After development, room-temperature storage of photographic materials is normally OK.

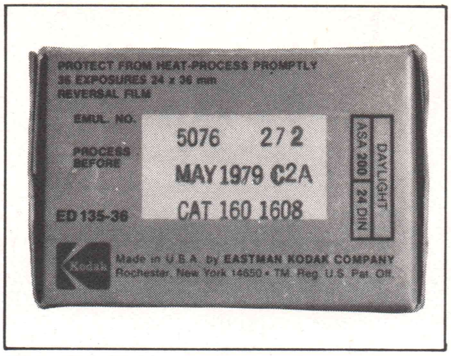
An exception to the above is color films intended for professional use and some special b&w films. These should *always* be stored at reduced temperature—follow the film manufacturer's instructions.

Film should be sealed before storage and allowed to return to room temperature before breaking open the seal, otherwise moisture may condense in the package and the film may be ruined. If you buy film in quantity, storing it in a refrigerator is a good idea provided you observe this precaution.

LOADING FILM INTO THE CAMERA

Lift the film-rewind knob and the back cover of the camera pops open. A crank in the top of the knob folds over and fits into a groove. If you have difficulty grasping the knob, unfold the crank and use it to pull upward on the knob.

Open the back cover all the way



Film should be exposed and processed before the expiration date stamped on carton. The number stamped above the expiration date is a *batch number* or *emulsion number* which identifies film made from a particular batch of emulsion. If you are shooting several rolls on an assignment, uniform film properties are assured by using rolls with the same batch number.

and inspect the interior of the camera. Occasionally it's a good idea to brush out the interior carefully with a *clean* soft brush, a puff of air from a rubber squeeze bulb, or a puff from a pressurized can of dust remover.

When cleaning the interior of the camera, remember the focal-plane shutter mechanism is delicate and treat it accordingly. Avoid touching it or blasting it directly with air.

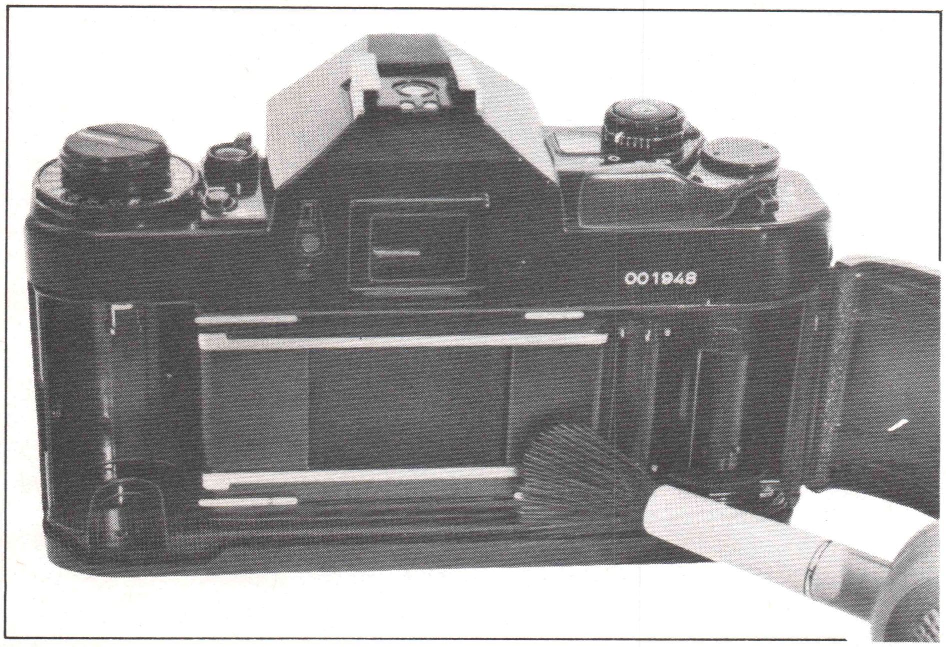
Drop the film cartridge into the chamber on the left side. Push down the rewind knob and rotate it slightly with your fingers if necessary to get it all the way down. This engages the fork on the end of the rewind shaft with the rotating spool of the film cartridge so you can later rewind the film.

Grasp the free end of the film and pull it across the back of the camera to the takeup mechanism on the right side.

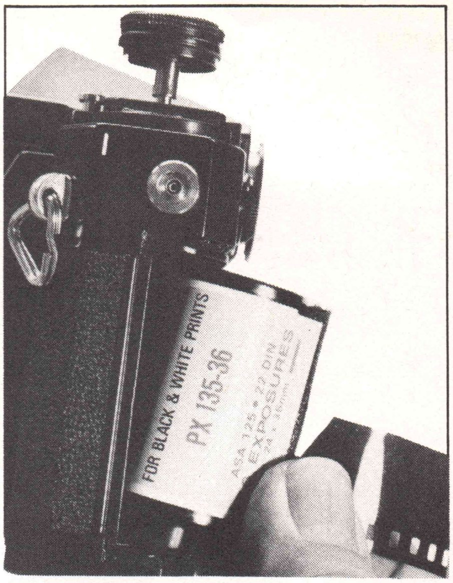
If the camera has a takeup spool with slots, place the free end of the film into any slot on the spool and operate the film-advance lever with your right thumb to turn the takeup spool one revolution, thus trapping the free end of the film in the slot of the spool. Use your left thumb or forefinger to place the sprocket holes of the film over the teeth of the sprocket which is beside the takeup spool.

When you are sure the film is caught in the takeup spool and is engaging the sprocket teeth, close the back of the camera.

Very gently rotate the rewind knob clockwise as though you were rewinding until you feel a slight resistance. That takes up any slack between cartridge and takeup spool.



Every time you load film, inspect the interior of the camera for dust and clean when indicated. A clean soft brush is handy. Be very gentle with the focal-plane shutter.



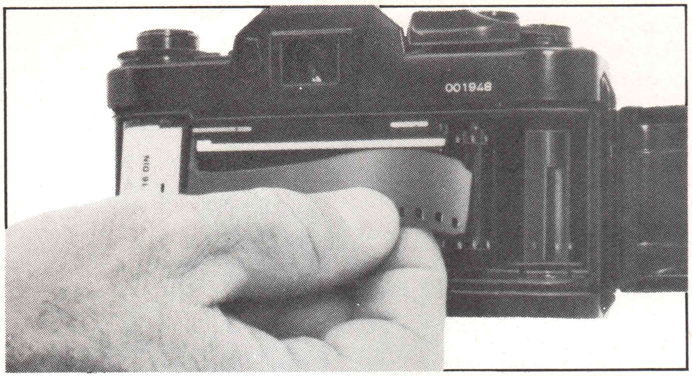
Drop in the film cartridge, tipping it as shown. Then push in the rewind knob, turning it if necessary to make it go all the way in.

With the rear cover closed, the frame counter on top of the camera should read S. It is automatically reset to S each time the back is opened. The first frame you are supposed to shoot is number 1. Operate the film-advance lever while watching the frame counter until it reads frame 1. Make the other camera-control settings and you are ready to shoot.

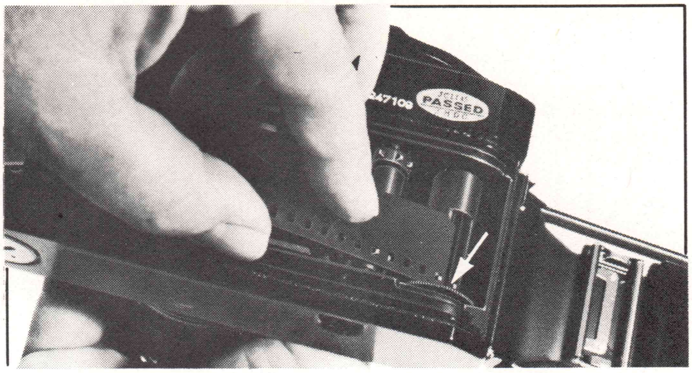
Watch the rewind knob as you advance the film to 1. It should turn, indicating the film is actually moving out of the cartridge onto the takeup spool. If it does not turn, you'd better open the back of the camera to make sure the film leader is firmly engaged in the takeup spool.

On most Canon cameras, to advance the film from S to 1, you have to trip the shutter and use the film-advance lever repeatedly until you arrive at frame 1.

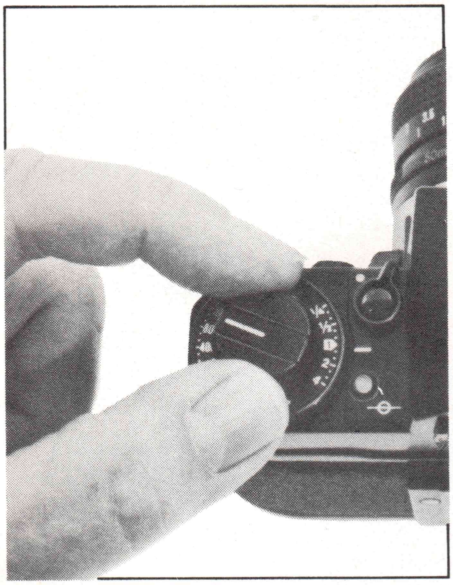
The Canon EF has an Automatic Blank Shot Mechanism which gets you to frame 1 a little faster and with less trouble. You can advance the film repeatedly with the lever but without depressing the shutter button until you arrive at frame 1. To go beyond that, you have to push the shutter button in the normal way. You must still tension the



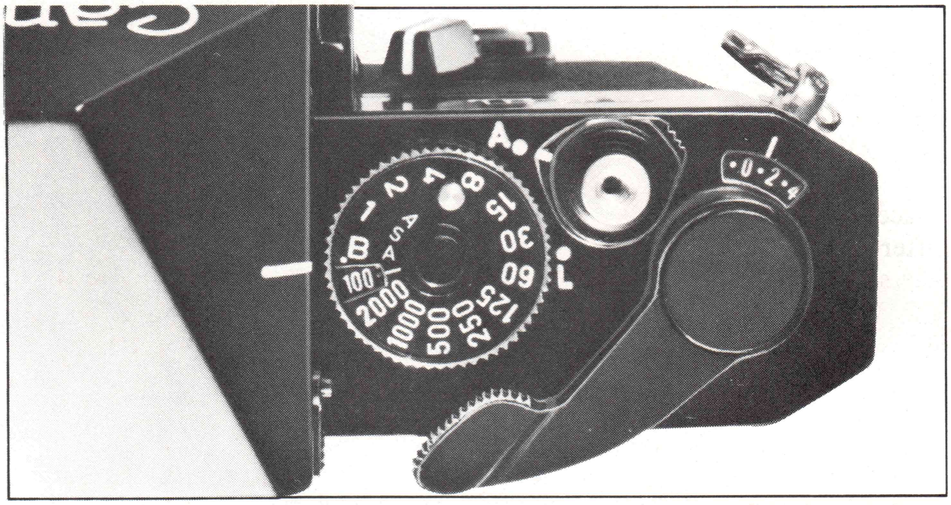
Grasp the free end of the film, pull it across the back of the camera, and insert into any slot in the takeup spool at far right.



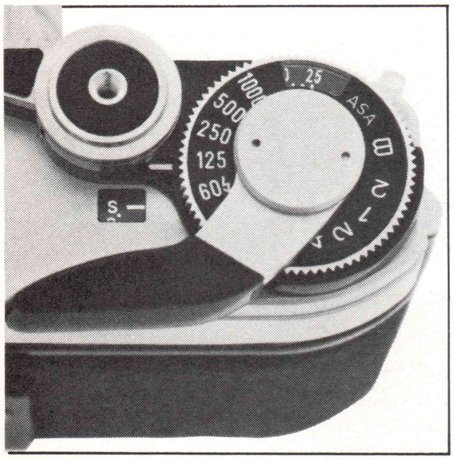
With the end of the film in a slot of the takeup spool, rotate the spool so it traps the free end of the film. This can be done with the Film-advance Lever or with the knurled flange (arrow) on the takeup spool. Correct direction of rotation is shown by an arrow on the takeup spool. Before closing the camera back, advance the film far enough so teeth on *both* ends of the sprocket are fitted into sprocket holes in the film. Also, be sure the film is pulled *flat* across the back of the camera, without any slack in the path. If there is slack, advance the film a bit more.



Close the back and turn the rewind knob clockwise until you feel slight resistance. This tensions the film and lets you verify proper loading by watching the rewind knob turn counterclockwise as you advance film.



Advance the film until the frame counter passes 0 and stops on the first dot past 0. This is frame 1. Watch the rewind knob to be sure it turns while you are advancing to frame 1. The frame numbers you see while shooting will agree with the numbered frames on most negative film and the numbers printed on slide mounts. This is handy if you keep notes about your exposures. Frame-counter numbers 20 and 36 are colored red to remind you that you are at the end of a 20-exposure or 36-exposure cartridge.



Loading the camera automatically resets the frame counter to S, which means *start winding*.

film with the rewind knob and watch to make sure it turns as you advance the film.

The film takeup method used in Canon FTb models is called **QL** for Quick Load. The mechanism grasps the free end of the film automatically.

It is important to understand that the frame counter does not actually count frames of film as they go through the camera. It only counts the number of times you have operated the film-advance lever. If the film leader is caught in the takeup mechanism and is advancing through the camera each time you operate the lever, the frame counter will be telling the truth. If the film leader is not grasped by the takeup, it will not move through the camera as you work the advance lever, but the frame counter will keep on indicating higher numbers.

When you are loading a camera, all of the film you pull out of the cartridge becomes light struck and when developed it will be black. The purpose of advancing film after you close the camera is to move the light-struck portion across the film plane and onto the takeup, so you can start taking pictures with unexposed film.

Loading and unloading a camera should always be done in subdued light. If you have to do it outdoors, shade the camera with your body to avoid direct sunlight on the film cartridge.

The cartridge should be left in the package until you are ready to use it and returned to the package or some other light-tight container as soon as you remove it from the camera.

Most camera manuals advise you to use a lens cap over the lens when not shooting, and to leave it in place while firing the blank shots after loading the film. You can do the same thing with your hand over the lens when changing film in a hurry, if you don't touch the lens itself.

There is no harm in firing blank shots with the lens uncovered except it gets confusing later. You can end up with well-exposed negatives or slides which show somebody's feet or a handsome navel.

If you are having a really busy day shooting pictures and expose a lot of film on a lot of different subjects, these non-blank blank shots can confuse you later. I once got an excellent blank shot I was tempted to exhibit with the title "Tree Shadows on Feet." I was certain the picture had a message and you know what it is.

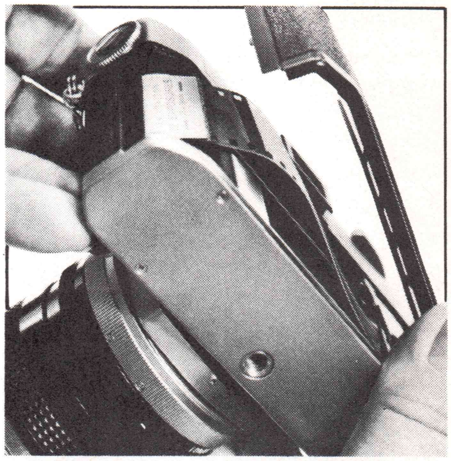
FILM GUIDING AND FLATNESS

There are four polished metal rails, two above and two below the focal-plane shutter opening in the back of the camera. The film rides on the two inside rails. They are separated enough not to be in the picture area—in fact they are directly underneath the sprocket holes. The outer two rails are edge guides. They stand slightly higher than the inner rails so the edges of the film are guided in a straight path from cartridge to takeup.

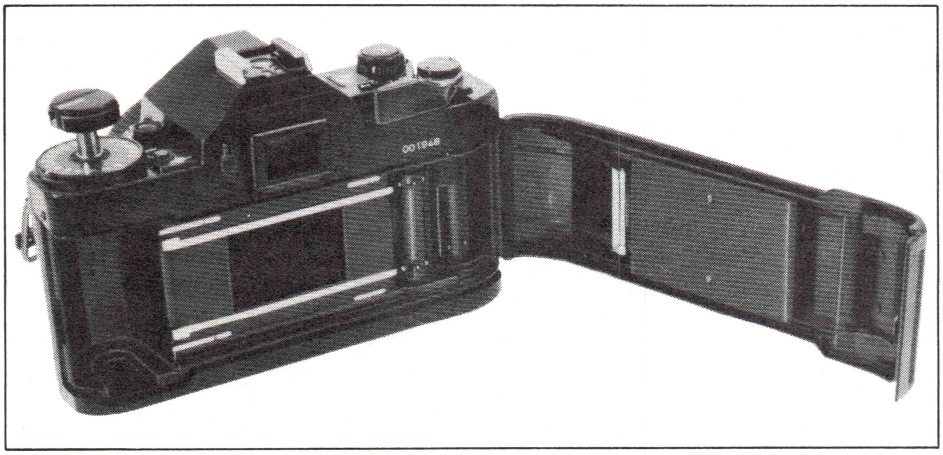
Because film is wound up inside the cartridge, it tends to curl in the long direction as it is pulled out and across the camera. Because the film is layers of different materials—the base and the emulsion—it may tend to curl crossways also, depending on humidity.

A spring-loaded pressure plate is on the inside of the rear cover of the camera. When the cover is closed, this flat smooth plate gently presses against the two outer guide rails and contacts the back of the film. The two outer guide rails hold the pressure plate away from the two inner rails a small amount to allow for the film thickness. This creates a channel closely confining the film to keep it traveling straight across the camera and hold it flat while being exposed.

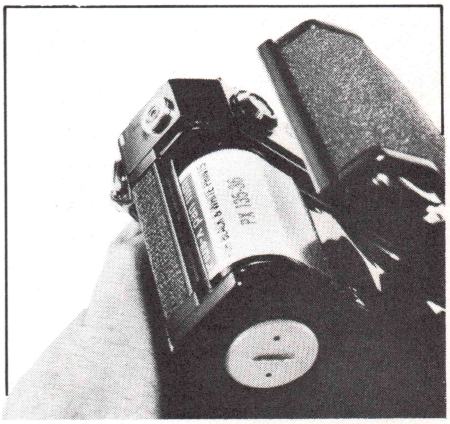
The film is in contact with camera parts everywhere it can safely



With all Canon cameras, the film should lie flat across the back when the camera back cover is closed—*without excessive slack as shown here.* Slack in the film path causes the film cartridge to tip up which prevents the back from closing properly. If you force it, you may damage something. If the cartridge tips up due to excessive slack, operate the Film-Advance Lever to remove slack until the cartridge lies flat.



Metal rails on camera body guide film and hold it straight. Smooth metal pressure plate on inside of back cover presses against film in camera to hold it flat when cover is closed.



This is the way the film cartridge should look when you close the camera back. Check film type and speed to be sure you know what film you have put in the camera, then snap the back closed.

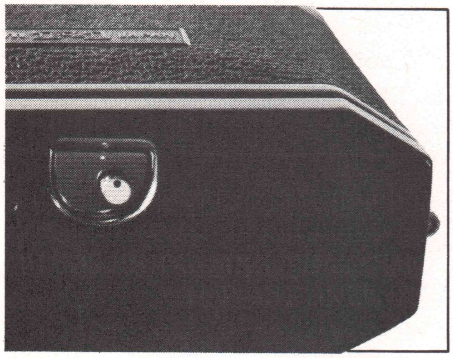
be touched without scratching the emulsion. The inner guide rails touch the emulsion side of the film in the sprocket-hole area. The outer rails touch the edges of the film. The pressure plate touches the back side of the film—the base. If the pressure plate scratches the back side of the film, those scratches will show in a slide or print. Dirt on the pressure plate or gouges due to extreme abuse can scratch the film.

REWINDING FILM

When you have exposed the last frame in the cartridge, the film advance lever will become difficult to move. *Don't force it!* If the lever completed a full stroke, the camera is cocked and there is a fresh frame in position. You can shoot that frame. If the lever only moved part of a stroke, rewind the film immediately.

Film wound on the takeup side of the camera is not protected from light. If you don't rewind immediately and later forget that you didn't, you can ruin the entire roll by opening up the back of the camera.

On the bottom plate of the camera, directly below the film advance lever is a small button called the Rewind Button, which must be depressed to rewind.



To rewind, depress the Rewind Button on the camera bottom and hold it depressed for the first few turns of the rewind crank. After that it will stay in place without your finger on it.

Because both of your hands will be busy rewinding rather than supporting the camera, I think it's a good idea to have the neck strap around your neck when rewinding. It helps to support the camera and eliminates any chance of dropping it.

By rewinding slowly and paying attention to the feel of the rewind crank, you will be able to tell when the film end pulls clear of the takeup mechanism. When that happens, there will be about as much leader extending from the cartridge as there was when you loaded the camera.

It's a good idea to stop rewinding at that point, leaving some leader sticking out of the cartridge. The light trap where the film comes out of the cartridge works best when the opening is partially filled with film. If you wind it all the way into the cartridge you increase the chance of a light leak into the cartridge which can fog the exposed film.

The frame counter in some Canon cameras remains at the highest number it counted while you rewind, then resets to S when you open the camera back. An A-series camera is different. It will reset to S automatically if you open the camera, but normally you never see it happen. When rewinding, the frame conter moves backwards, counting down to 0. Continue rewinding until the counter backs up to S. Then it is safe to open the camera back. If the film is not pulled free of the takeup spool, another turn of the rewind crank should do it. This helps you avoid winding the film all the way into the cartridge. Some photographers mark or bend the leader of exposed film, to guard against loading it twice.

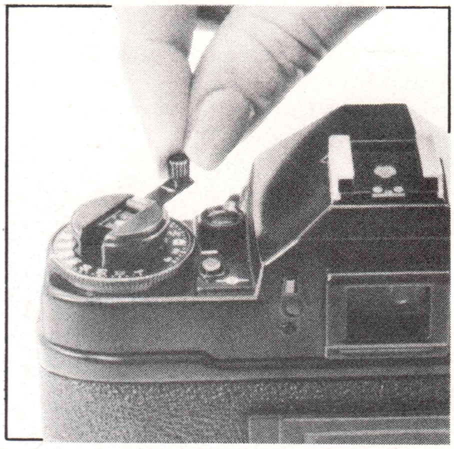
You shouldn't ever get confused about whether a roll of film has been exposed or not if you form the habit of never opening the factory package until just before loading the cartridge into the camera.

Another good habit to form is *look at the cartridge* just before you close the camera back cover. If you carry more than one type of film and you are busy shooting action or something that takes a lot of concentration, it's easy to grab and load the wrong kind of film while your mind is busy with something else.

Sometime during the loading procedure you should have an automatic check point to verify what's in the camera. I formed the habit of doing this just before closing the back. It's not too late to take it back out if you have the wrong film and it is reassuring to *know* you have the right film in the camera.

Read two things on the cartridge: the film type, such as Kodachrome 25, and the film-speed number, such as 25.

On closing the camera back, *immediately* check the ASA film speed dial on the camera to be sure it is set at the right number. Do that even before advancing the film to frame 1.



Flip up the Rewind Crank and turn it clockwise to rewind. Rewind slowly, particularly when the humidity is low, to avoid static electricity discharges inside the camera which will mark the film.

8

EXPOSURE CONTROLS AND THEIR EFFECTS

Suppose you have just set the exposure controls. The aperture is set for *f*-5.6 and the shutter speed is set for 1/125. Those settings determine some total exposure on the film—some *exposure value* which we abbreviate EV. Any other pair of settings which give the same EV will make the same exposure on the film.

Because there are usually several pairs of *f*-stop and shutter-speed settings which give the same exposure on the film, it is convenient to have some way of saying how much exposure it is rather than reciting all possible pairs of settings which give that same exposure.

Canon doesn't use EV numbers on the cameras, but they are used in the specs for Canon cameras, so you should have some idea of what they are about. An EV table is shown below.

Pairs of *f*-stop and shutter-speed settings which represent the same amount of exposure or the same EV number can be found on this table.

EV numbers themselves are just labels for identification of exposure stems in sequence.

Because EV numbers represent a *combination* of aperture and shutter speed to give a particular exposure, we can say:

Exposure Value =
Aperture Value + Time Value

which can be abbreviated

EV = Av + Tv

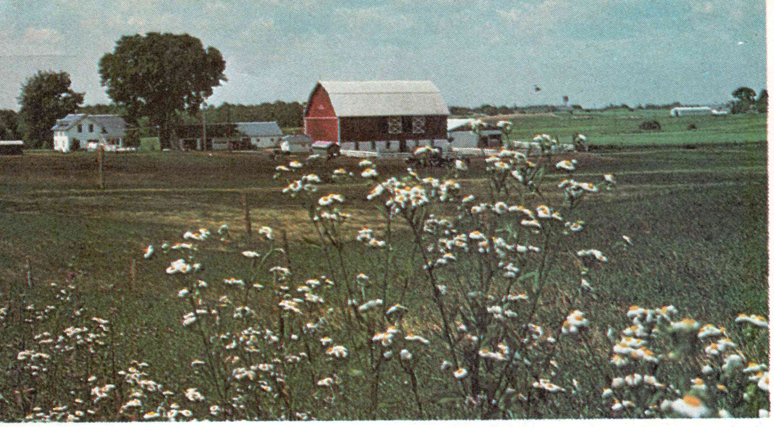
COUNTING UP AND DOWN THE EXPOSURE SCALE

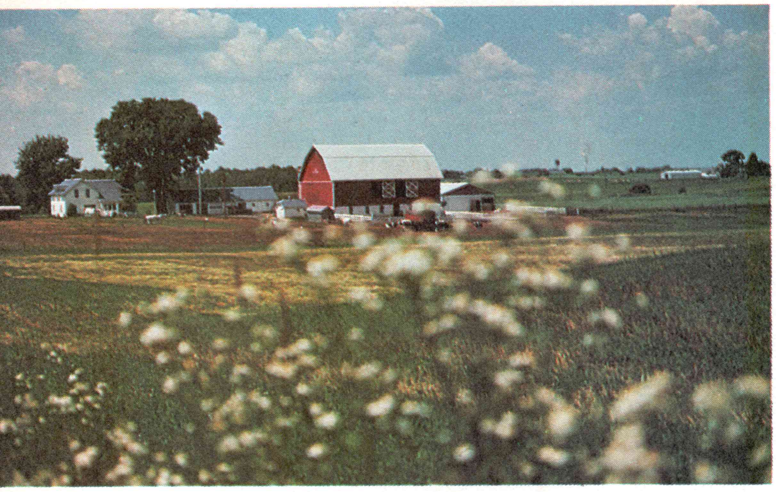
You don't need to memorize any EV numbers, but please notice the

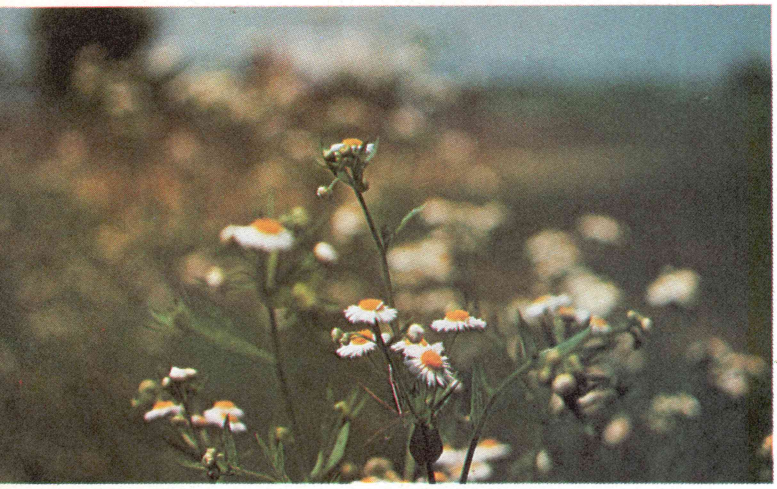
EV NUMBERS & EQUIVALENT EXPOSURE SETTINGS

	SHUTTER SPEED																			
EV	4 min.	2 min.	1 min.	30 sec.	15	8	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000
−8	*f*-1																			
−7	1.4	*f*-1																		
−6	2	1.4	*f*-1																	
−5	2.8	2	1.4	*f*-1																
−4	4	2.8	2	1.4	*f*-1															
−3	5.6	4	2.8	2	1.4	*f*-1														
−2	8	5.6	4	2.8	2	1.4	*f*-1													
−1	11	8	5.6	4	2.8	2	1.4	*f*-1												
0	16	11	8	5.6	4	2.8	2	1.4	*f*-1											
1	22	16	11	8	5.6	4	2.8	2	1.4	*f*-1										
2	32	22	16	11	8	5.6	4	2.8	2	1.4	*f*-1									
3	45	32	22	16	11	8	5.6	4	2.8	2	1.4	*f*-1								
4	64	45	32	22	16	11	8	5.6	4	2.8	2	1.4	*f*-1							
5		64	45	32	22	16	11	8	5.6	4	2.8	2	1.4	*f*-1						
6			64	45	32	22	16	11	8	5.6	4	2.8	2	1.4	*f*-1					
7				64	45	32	22	16	11	8	5.6	4	2.8	2	1.4	*f*-1				
8					64	45	32	22	16	11	8	5.6	4	2.8	2	1.4	*f*-1			
9						64	45	32	22	16	11	8	5.6	4	2.8	2	1.4	*f*-1		
10							64	45	32	22	16	11	8	5.6	4	2.8	2	1.4	*f*-1	
11								64	45	32	22	16	11	8	5.6	4	2.8	2	1.4	*f*-1
12									64	45	32	22	16	11	8	5.6	4	2.8	2	1.4
13										64	45	32	22	16	11	8	5.6	4	2.8	2
14											64	45	32	22	16	11	8	5.6	4	2.8
15												64	45	32	22	16	11	8	5.6	4
16													64	45	32	22	16	11	8	5.6
17														64	45	32	22	16	11	8
18															64	45	32	22	16	11
19																64	45	32	22	16
20																	64	45	32	22

$$EV = 3.3\ \text{Log}_{10} \left(\frac{f^2}{T}\right)$$







These three pictures show depth of field being used as a photographic control. In the top photo, focus is pretty good everywhere. A small aperture—*f*-16—was used to give maximum depth of field.

In the center shot, a large aperture was used—*f*-1.4—to give short depth of field. Subject of interest is the barn, so the lens was focused on the barn.

In the bottom photo, large aperture was used again but the lens was focused on the flowers. The barn and some of the flowers are beyond the depth of field and are out of focus.

Good photography nearly always requires *deliberate* control of depth of field.

plan so you can figure or "count" pairs of camera settings quickly in your head. It may seem odd that I want you to do this when everybody knows that modern cameras do all the thinking for the operator. That's true only in normal shooting situations. As we get deeper into how things work, you will see your camera equipment can do a lot more if you back it up with a little brain work of your own.

EFFECT OF APERTURE SIZE

Field of view of a particular lens means the total width and total height of the scene as viewed through that lens. Different lenses have different fields of view.

The camera lens also "sees" near and far objects, so there is some depth or distance within the view of the lens—from the camera all the way to the most distant object in the scene or to infinity if you point the lens at the sky.

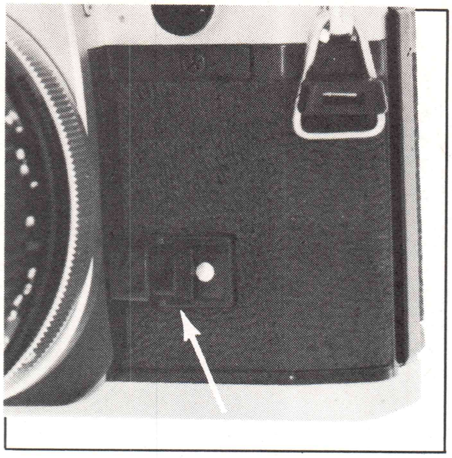
Not all objects between zero distance from the camera and infinity will be in sharp focus on the film. The distance between the nearest object in good focus and the farthest object in good focus is called *depth of field.*

With an adjustable camera, depth of field is controlled by aperture size. If you are taking a portrait of a person against a foliage background, the picture will often be improved by "throwing" the foliage out of focus.

When you become used to having control of depth of field in your pictures, it will become as important to you as any other photographic control on your camera.

Smaller lens apertures give more depth of field. When shooting at *f*-22 with some lenses virtually everything in view will be in good focus—beyond a certain minimum distance. When shooting at *f*-1.4, depth of field will be greatly reduced. Objects both front and back of your subject will be out of focus.

With cameras similar to the F-1, The Stopped-Down Lever is convenient to operate with your right hand.



With A-series cameras such as this AT-1, operate the Stopped-Down Lever with your left hand.

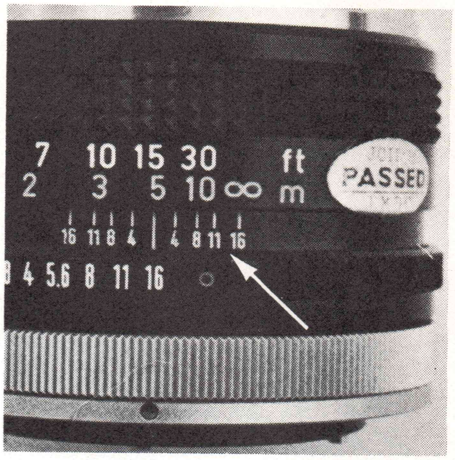


Figure 8-1/This lens is set at *f*-16 and focused at a distance of about 5 meters. The depth of field indicator scale (arrow) is the set of numbers on each side of the index mark, ranging from 16 to 16. Depth of field is the span between any pair of numbers on that scale which have the same value, such as 4 to 4, or 11 to 11. The pair to use is determined by the *f*-stop setting of the lens. In this example, use 16 to 16 because the lens is set at *f*-16.

Depth of field is found by reading the focused distance scale opposite 16 and 16 on the depth of field indicator. Good focus is from about 2.6 meters to infinity (∞) or about 8 feet to infinity if you prefer to use the scale marked in feet.

You need to know the depth of field you are actually getting on the film at the moment you take the picture. After the picture is shot, it's too late to change it.

Because Canon cameras allow viewing through wide-open aperture so you get the brightest image on the viewing screen, you are not seeing the depth of field which will result when the camera closes aperture to the value you have preset on the lens.

After composing, focusing and setting the exposure controls, the last step should be a check of depth of field to see if it's satisfactory If you have too much depth of field and some distracting object in the background is in sharp focus, you may wish to use a faster shutter speed so you can use larger aperture and get less depth of field. Or the depth of field may be too limited for your purpose and you may wish to use a smaller aperture to get more.

The way to see how much depth of field you will get at shooting aperture is to stop down the lens by operating the stopped-down lever on the front of the camera.

When you operate the lever by moving it toward the lens, the image on the viewing screen gets darker because less light comes in the smaller aperture—unless you happen to be shooting at maximum aperture. At the same time, the depth of field you see in the viewfinder changes to what it will be on the film. With some practice, you learn to ignore the change in brightness of the image and judge depth of field.

In dim light, or if you are using a very small aperture, the viewfinder image may be too dark to satisfactorily judge depth of field. If so, you can rely on the depth-of field scale on the lens itself.

With the A-1 and AE-1 cameras, there are some precautions and complications that concern stopping down the lens with the camera set for automatic operation. These result from the way the levers on lens and camera work together, as explained in Chapter 10. This affects operating procedures of the various camera models in different ways you can read about in the description of each camera in Chapter 18.

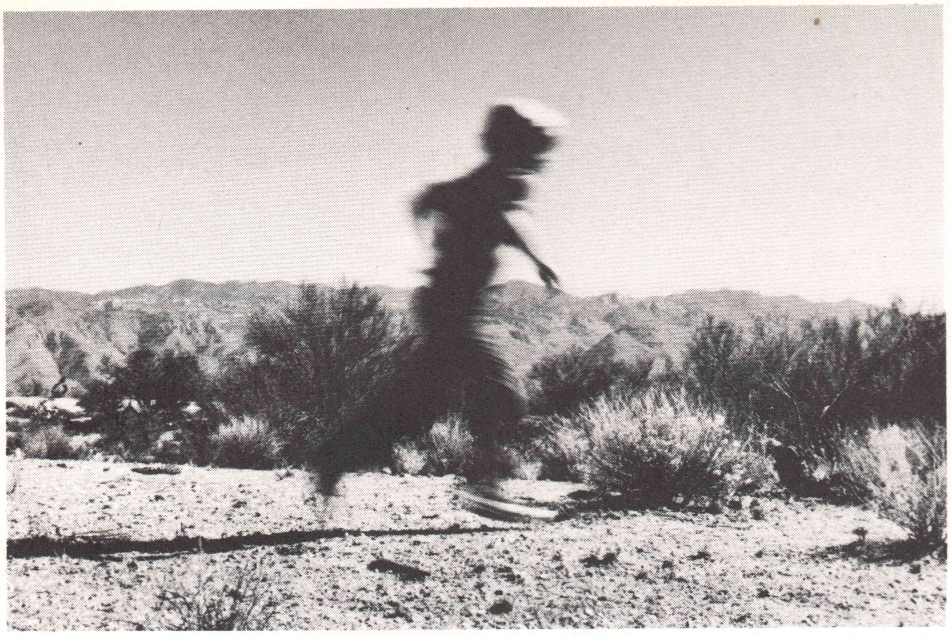
With some cameras you may find it more convenient to estimate depth of field by consulting the depth-of-field scale on the lens, rather than by stopping down the aperture.

HOW TO READ THE DEPTH-OF-FIELD SCALE

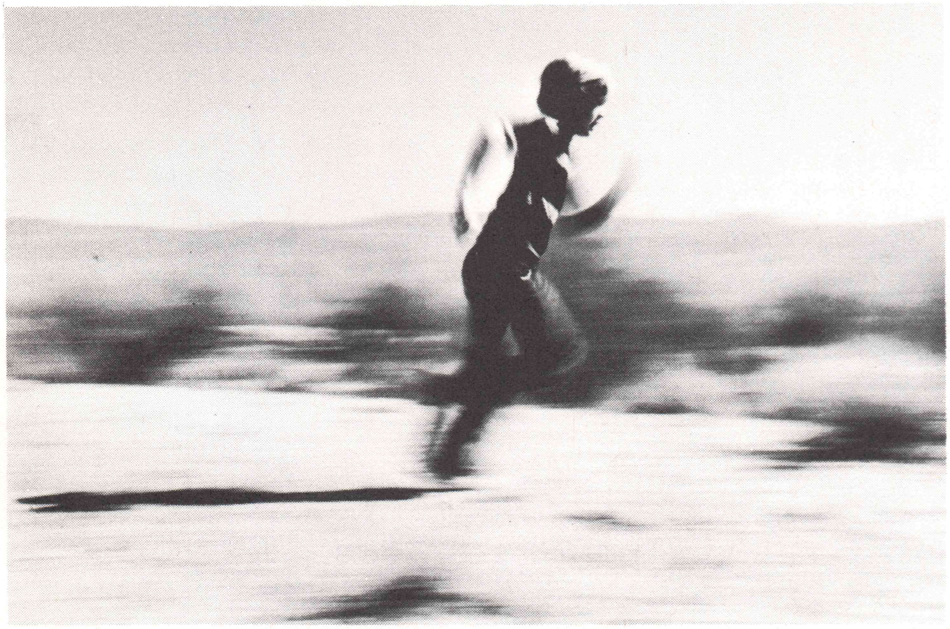
The depth-of-field capability of lenses varies with focal length. Shorter lenses have more depth of field. For any particular lens, depth of field is affected both by aperture size and the focused distance of the lens.

You will get more depth of field when the lens is focused at greater distances from the camera, so the depth-of-field indicator on the lens is operated by the focusing control of the lens.

The depth-of-field indicator on Canon lenses is pairs of lines engraved on the lens, centered on the index mark which you use to read focused distances from the focusing ring. Rather than read that again, look at Figure 8-1.



If the camera is stationary, shutter speed is low, and a moving subject is in the field of view, the subject will blur while everything else is sharp.



Following subject motion by moving the camera is called *panning*. If you pan at the same speed as the subject, background is blurred and subject is sharp. However panning horizontally only corrects *horizontal* subject motion. Arms and legs moving vertically are blurred just as much as if the camera were not panned. Pictures like this are fun.

RULES ABOUT DEPTH OF FIELD

Smaller apertures give more depth of field. Shorter focal lengths give more depth of field. Longer distances between subject and camera give more depth of field in the vicinity of the subject.

EFFECT OF SHUTTER SPEED

Shutter speed has three effects: It affects how much a moving subject is blurred on the film.

With a hand-held camera, it affects the amount of image blurring of a stationary subject due to your inability to hold the camera absolutely steady.

It affects the aperture size you can use because aperture and shutter speed in combination must give the desired exposure.

Blurring of a moving subject is most noticeable when the subject is moving directly across the field of view of the camera–in other words, at right angles to the direction the camera is pointed. If blurring is a problem and you can't solve it any other way, move your shooting location so the subject is traveling more nearly toward or away from your position.

Both shutter speed and lens focal length determine blurring due to camera shake when you are handholding. Also how steady you are and the way you support the camera. Some people simply do better than others and some improve by adopting good camera-handling technique with conscious attention to the problem and some practice.

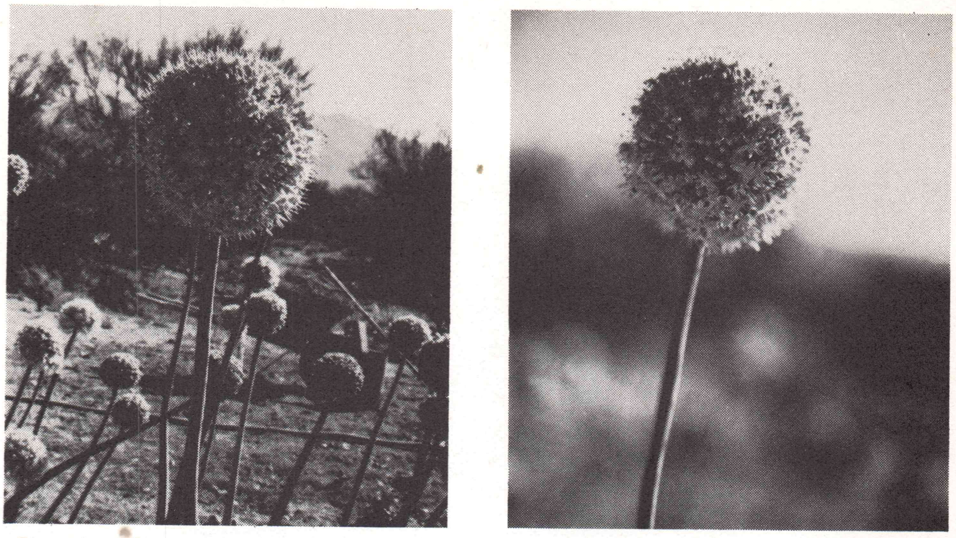
It's easier to hand-hold with shorter focal lengths because they magnify less. Shake is magnified by longer lenses just as the image itself is. Slight jiggling of the camera produces a visual effect on the print very similar to being out of focus. More pictures are harmed by camera shake than any other cause.

A guide to shutter speeds when hand-holding the camera is to take the reciprocal of the lens focal length. The reciprocal of any number is that number divided into one. The reciprocal of 50 is 1/50 and so forth. Use the reciprocal of focal length as the longest time of exposure that can safely be hand held unless you have proved to yourself that you can hold the camera steady at slower shutter speeds. With a 200mm lens, use 1/250 because 1/200 isn't an available shutter speed—you must set the shutter-speed control exactly on the marked speeds.

With a 50mm lens, you shouldn't have any trouble shooting at 1/60 and most people who are careful about it can shoot at 1/30. By bracing yourself you can do better and by pressing the camera against the side of a building or a post, you can do still better. Don't pass by a good shot on account of this rule of thumb. Give it your best effort and get the picture. If it blurs you can always say you did it on purpose.

Sometimes there is conflict between the aperture you would like to use for depth-of-field effect and the shutter speed you need to stop motion or to hand-hold the camera. The two adjustments together must satisfy a third requirement—correct exposure.

However, exposure is not the same for all film types because films have different speed ratings. It always helps to select a film speed for the kind of shooting you intend to do—it gives you the best chance of being able to use appropriate apertures and shutter speeds.



Choosing film speed for the kind of photos you intend to make is helpful. A way to eliminate background is, use large aperture to reduce depth of field. In bright daylight, slow film helps.

EFFECT OF FILM SPEED

The film-speed rating is assigned by the manufacturer and is a way of stating how much exposure a particular type of film requires. When you dial the film-speed number into your camera, you set up the camera light-metering system so it gives the desired exposure for that film type.

Among commonly-available film speed ratings, ASA 25 is considered slow, 125 is intermediate, and 400 is fast. More exposure is required when you have ASA 25 film in your camera than when using ASA 400.

Here's another rule of thumb that's worth remembering:

To photograph a subject illuminated directly by sunshine, use *f*-16 and a shutter speed which is the reciprocal of the ASA film speed. If you are using ASA 25 film, shoot at 1/25 second—1/30 will be close enough. If you are using ASA 125 film, shoot at 1/125 second, and so forth.

Naturally you don't have to shoot at *f*-16 and 1/30 with ASA 25 film, even if you use the rule. You can change *f*-stop and make compensating changes in shutter speed to end up a long menu of possible settings in sunlight as follows:

f-16	1/30
f-11	1/60
f-8	1/125
f-5.6	1/250
f-4	1/500
f-2.8	1/1,000
f-2	1/2,000

These pairs of exposure control settings will all give the same amount of exposure because each step toward larger aperture is balanced by one step toward shorter exposure time. Therefore they should all have the same EV number. In the EV table on page 29 you will see that each of these pairs of settings is EV 13. You will also see other possible pairs of control settings that give EV 13.

Without putting film in your camera or even going out in the hot sun, you can use the menu just figured to see how it's going to be when you go out there.

Assume you intend to shoot action with a 200mm lens. You decide to shoot at 1/500 or 1/1,000 so you can hand-hold the camera. Depth of field will be poor because you also have to shoot at large aperture—*f*-4 or *f*-2.8. If you close down to *f*-11 or *f*-16 to get better depth of field, the action will blur at the slow shutter speeds and you will not be able to hand-hold that long lens.

The only way out of this problem is not to use ASA 25 film for this shooting assignment because the film is too slow. With some films, you can deliberately underexpose to operate at faster shutter speeds than normal exposure requires. For these films, most labs

Sometimes artistic effects result from slow shutter speeds. These dancers are from the show "Up with People."

can make a compensation in development called *push processing.*

Let's try the whole deal again with ASA 400 film, which is faster by 4 exposure steps. You have to double four times to get from ASA 25 to ASA 400.

The choices in sunlight then become:

f-16	1/400–use 1/500
f-11	1/1,000
f-8	1/2,000–F-1 only
f-5.6	No shutter speed available
f-4	No shutter speed available
f-2.8	No shutter speed available
f-2	No shutter speed available

As you can see, using ASA 400 film in sunlight forces you to small apertures and fast shutter speeds. That very neatly solves the problem I just mentioned.

But if you are photographing people or flowers in the garden, you may not want depth of field from here to the back fence. A much more artistic photo usually results when the competing background is thrown out of focus by using less depth of field. With the settings required for 400 film speed, you can't reduce depth of field because you don't have fantastic shutter speeds. You can reduce the amount of light entering the camera by using a neutral-density filter on the lens as described in Chapter 15.

An oversimplified rule is to buy fast film for shooting in dim light such as indoors and slow film for shooting in bright light. But the amount of light alone is not the determining factor. You also have to worry about depth of field and shutter speeds.

RECIPROCITY FAILURE

By now it may seem that you can shoot at virtually any shutter speed you choose, simply by counting up or down the exposure scale, adjusting aperture to compensate for shutter-speed changes.

The reciprocity law indeed says so, but here is the fine print that takes it away:

People once thought the law applied to all values of light and time, but there are exceptions when the shooting light is either unusually bright or unusually dim. These exceptions are called reciprocity-law failure, usually known as *reciprocity failure.*

The problem lies in the nature of film, not in the camera. It is always due to light which is more or less bright than the design-range of the film emulsion. Even though reciprocity failure is caused by the amount of light, the best *clue* to the camera operator is shutter speed because unusually short shutter speeds mean there is a lot of light and unusually long exposure times mean the light is dim.

As a general rule for most amateur films, if you are shooting faster than 1/1,000, or slower than 1 second, you should think about the possibility of reciprocity failure. Consult the film data sheet supplied by the film manufacturer. Some films have a more limited "normal" range of exposure times than stated above.

The basic effect of reciprocity failure is always *less* actual exposure on the film than you expect. Therefore, the basic cure is to give more exposure by using larger aperture, more time, or both. For example, if an exposure meter or an exposure calculation suggests using *f*-4 at 4 seconds, the data sheet packed with the film may say to give one step more exposure than that to compensate for reciprocity failure. Use *f*-2.8 if it is available on the lens, or shoot at 8 seconds.

With b&w film, the film data sheet may call for more exposure and also a change in the development procedure. With color film, reciprocity failure can cause both underexposure and a color change on the film. The recommended compensations may be more exposure, use of a color filter on the lens, and a change in development.

Canon cameras and accessories will meter in dim light and make exposures that are well into reciprocity failure for most films. The A-1 camera can take pictures *automatically* by candlelight and time its own exposures up to 30 seconds, which will drive most films into reciprocity failure.

At the end of Chapter 15, you'll find tables giving reciprocity-failure corrections for some films. This information is current at printing time for this book, but film manufacturers often change their recommendations. To be sure, check the film data sheet or ask the film manufacturer. Even if you have the latest information, it usually pays to bracket exposures–meaning shoot one frame at the exposure you think is correct and additional exposures at more and less exposure. You can bracket in full steps with b&w film; half steps with color film.

SHUTTER PRIORITY OR APERTURE PRIORITY

When operating a camera, you make some choices of shutter speed and aperture which affect both exposure and the appearance of the picture.

There are some situations where you prefer to use a certain shutter speed. You may wish to stop motion of a subject with fast shutter speed, or you may wish to let it blur by using slow shutter speed. Whenever shutter speed is the most important control, you set it first and then accept whatever aperture is necessary for correct exposure. Operating a camera this way is called *shutter priority*.

If depth of field is the most important consideration, you set aperture first to get the depth of field you want. Then you accept whatever shutter speed is necessary for correct exposure. This is called *aperture priority*.

With a non-automatic camera, you set both aperture and shutter speed manually. You can choose between shutter priority and aperture priority freely, just by the way you decide to operate the camera.

Most automatic cameras are either shutter priority or aperture priority. This has provoked debate among automatic camera users, arguing which is best.

PROGRAMMED AUTOMATIC EXPOSURE

With either of the priority methods discussed so far, you have to make one of the settings. You must think about exposure and participate in making the settings of the camera.

The Canon A-1 is called a *multi-mode* camera because it has an astonishing *six different ways* to operate the camera. Right now I want to discuss just one of them: Programmed Automatic Exposure (AE). This mode of operation can be selected by a control on the camera.

With this mode, you do not participate at all in making the exposure control settings. The camera makes both of them for you. When you use this mode, you shouldn't have any particular shutter speed or aperture setting in mind, because the camera will select whatever it chooses according to a plan or *program* built into the camera.

The program is simple. If the light is very bright, the camera will select the smallest lens aperture and the shortest exposure time.

From there, the camera is impartial. It has no preference for either shutter speed or aperture. Therefore as the amount of light becomes less, the camera gradually makes small increases in both aperture size and exposure time, favoring neither. By the time the camera has opened aperture one step it has also increased exposure time by one step.

You can see the program in the accompanying graph. This graph shows *three* things: Shutter speed is represented by the vertical lines; aperture size is shown by the horizontal lines; and EV numbers are shown by the diagonal lines.

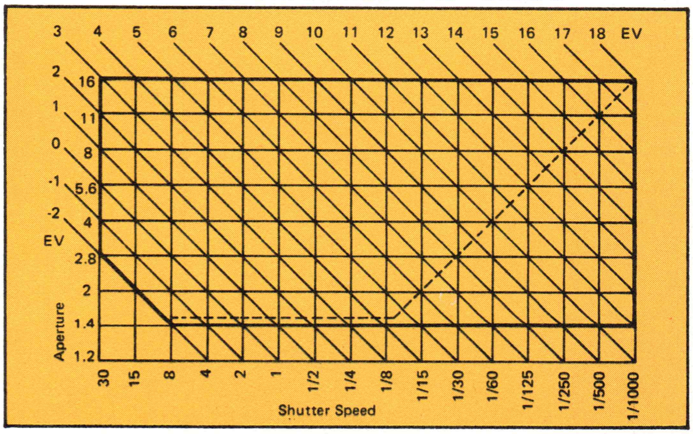
Starting at the upper right corner of the graph, the three values are: EV 18, 1/1000 second and *f*-16. To see what happens as the light becomes less, follow the dotted line down past EV 17 and stop at EV 16. Aperture has opened one step to *f*-11 and shutter speed has slowed down one step to 1/500 second.

These changes in aperture and shutter speed are made *steplessly*, meaning the values don't jump from one step to the next. They change gradually, in small increments.

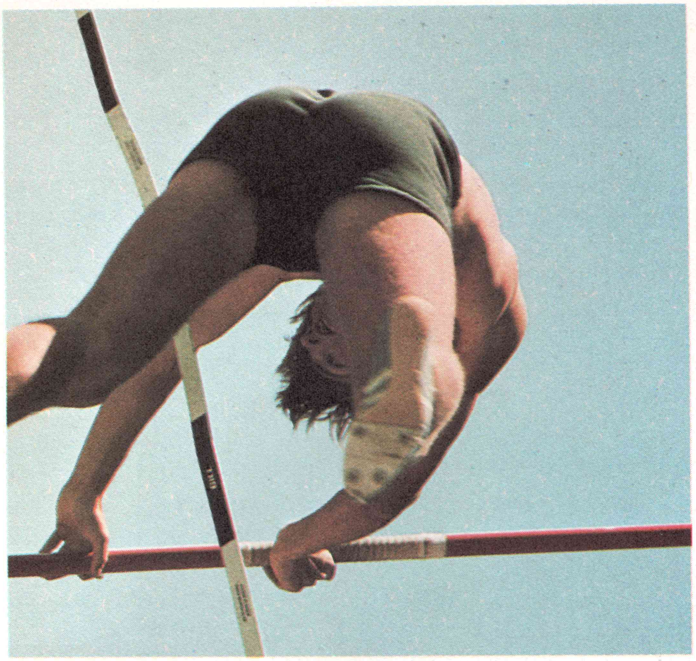
Notice that the program makes equal changes in aperture and shutter speed until the aperture is as large as it can get. The graph is for an *f*-1.4 lens and ASA 100 film in the camera. If you use a lens with smaller maximum aperture, the camera will open it as far as it will go and then stop. If

PRIORITIES OF CANON CAMERAS	
AT-1, FTb, TX, TLb	Non-Automatic
AE-1, EF	Shutter-Priority Automatic or Non-Automatic
F-1	Basically Non-Automatic Accessory Servo EE Finder converts F-1 to Shutter-Priority Automatic. Accessory Booster T Finder converts F-1 to Aperture-Priority Automatic.
A-1	Shutter-Priority AE (Automatic Exposure) Aperture-Priority AE Programmed AE Stopped-Down AE Electronic Flash AE Non-Automatic with Manual Control

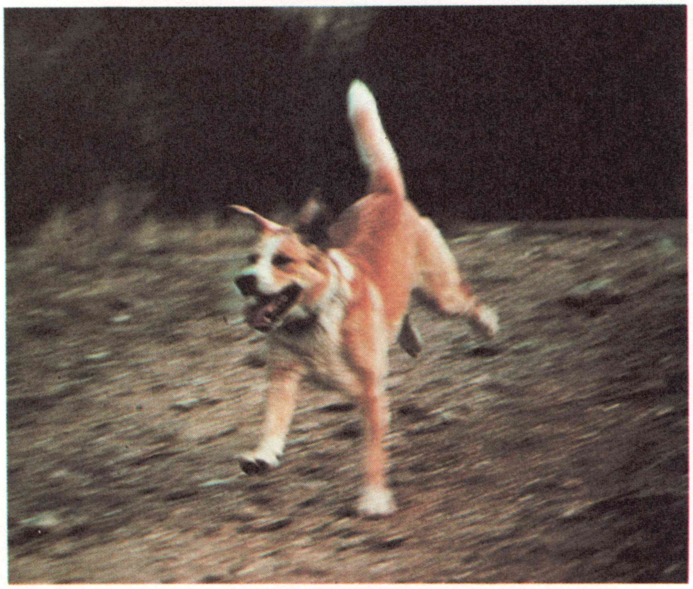
A-1 PROGRAMMED AE MODE



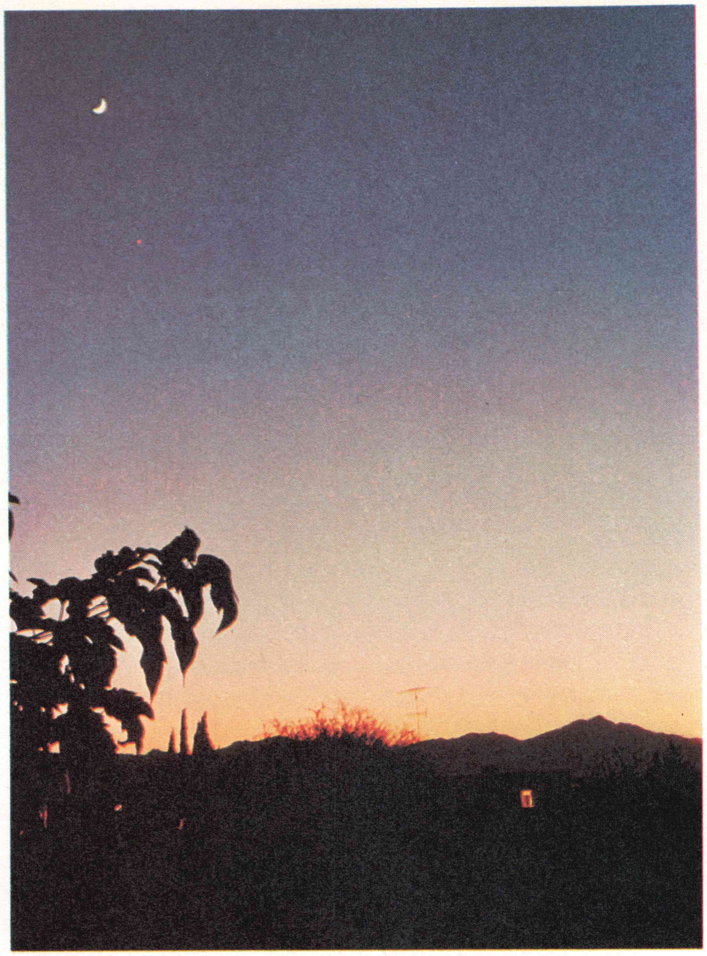
When set for Programmed AE, the A-1 camera sets both shutter speed and aperture automatically, following a built-in program shown by the dotted line.



A fast shutter speed "stops motion" and gives a sharp image of a moving subject. Because faster shutter speeds require larger apertures you may find a depth of field problem. Notice the vaulter's foot is out of focus. 200mm lens.



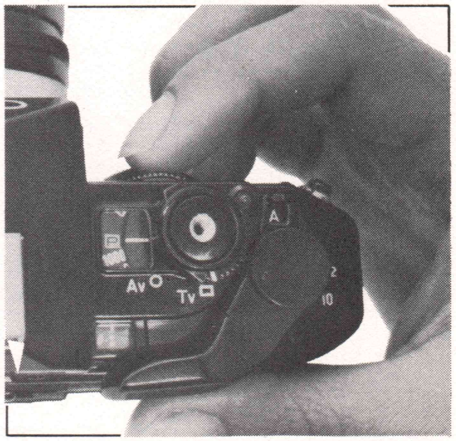
Sometimes a little bit of image blur helps the picture. It conveys the feeling of motion and adds realism to a subject which is obviously moving. I moved the camera to follow the running dog. This blurred the terrain. 200mm lens.



Reciprocity failure is not always a disaster and sometimes not even noticeable. This scene was exposed automatically. The camera timed itself and ran 15 seconds. Underexposure due to reciprocity failure made the sky color more intense.

you use film with a different speed, the shape of the graph doesn't change, but the numbers do.

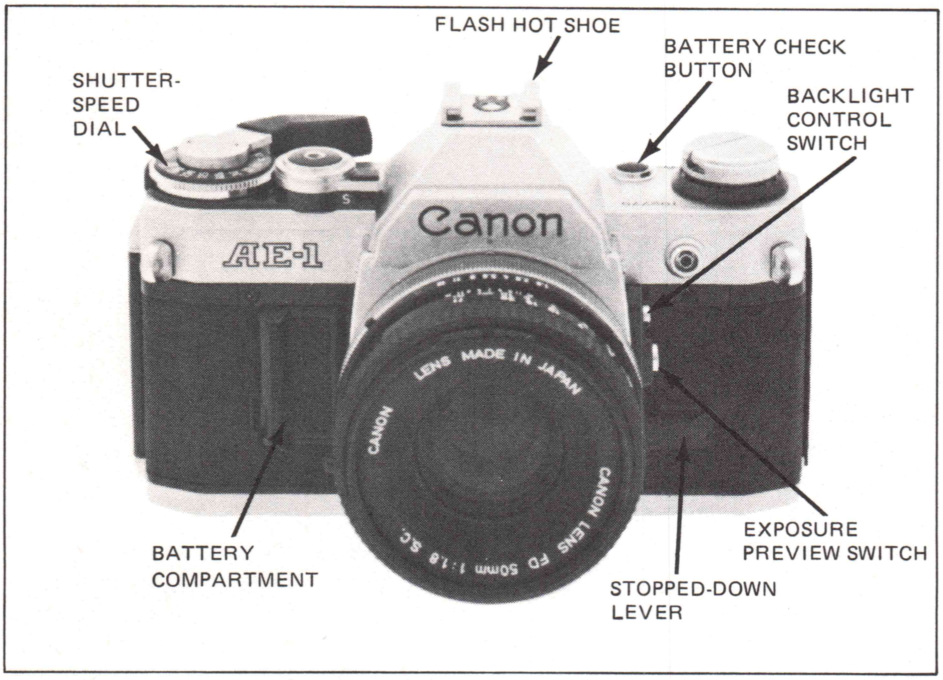
When the camera has opened lens aperture as far as possible, it then becomes aperture-preferred by necessity. Aperture remains wide open and the camera uses increasingly longer exposure times until it goes as far as the program will allow. On the graph, you can see that the program ends at 8 seconds. Even though the camera is capable of settings as long as 30 seconds in other modes of operation, it can use only 8 seconds or shorter in the programmed AE mode—with ASA 100 film.

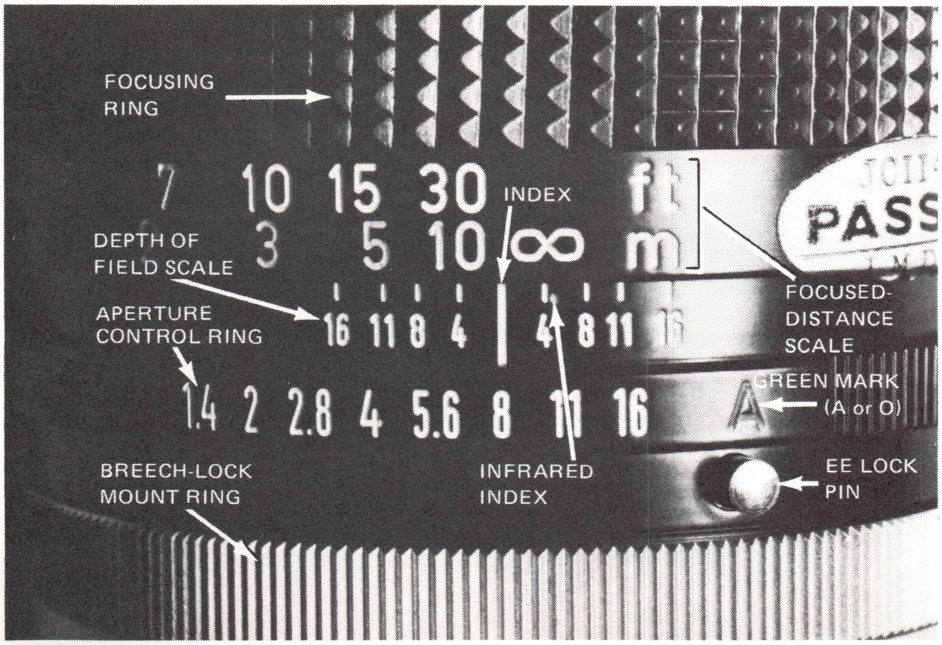


To select Programmed AE with the A-1 camera, operate camera controls so the letter P appears in the window as shown here.

9

CAMERA CONTROLS


FLASH HOT SHOE
BATTERY CHECK BUTTON
SHUTTER-SPEED DIAL
BACKLIGHT CONTROL SWITCH
BATTERY COMPARTMENT
EXPOSURE PREVIEW SWITCH
STOPPED-DOWN LEVER


FOCUSING RING
INDEX
DEPTH OF FIELD SCALE
APERTURE CONTROL RING
FOCUSED-DISTANCE SCALE
GREEN MARK (A or O)
BREECH-LOCK MOUNT RING
INFRARED INDEX
EE LOCK PIN

This is a good time to gather up all camera controls discussed so far, along with most of the others.

Because it is convenient to have all these features discussed in one place, I'll describe each one briefly. Some are review because they have already been mentioned. In one case—the Stopped-Down Lever—there are additional functions which have not yet been described.

The camera illustrated in this chapter is the AE-1 which is generally representative of all Canon SLR's. There are some differences among the various camera models. Even when a control is designed or located differently, it usually has the same name and function as described here. All current Canon models are shown in Chapter 18, with callouts for the controls.

Focusing Ring—Used to focus the lens at different distances from the camera. Conventional lenses focus to infinity—symbol ∞—but the near limit is different among various lenses. When considering a lens, check its near-focus limit.

Focused-Distance Scale—Shows the distance from the film plane in the camera to the point of best focus.

Depth-of-Field Scale—Works with the Focused-Distance Scale to show depth of field at different apertures.

Aperture-Control Ring—Used to set lens aperture. When the automatic-aperture feature is being used, aperture will not stop down until the moment of exposure.

Breech-Lock Ring—Attaches lens to the camera. Looking at the front of

To set self-timer on AE-1 and AT-1 cameras, move lever forward to uncover LED lamp (arrow). Start the cycle by depressing the shutter button. LED blinks during countdown so you know the self-timer is working.

the camera, attach the lens by turning the Breech-Lock Ring clockwise; remove by turning counterclockwise. With older lenses, this ring can be rotated with the lens off the camera. This will prevent installation of the lens until you rotate the Breech-Lock Ring fully counterclockwise.

On later lenses, a lock holds the ring in the fully counterclockwise position while it is off the camera so you don't have the problem.

Self-Timer Lever—Some cameras accomplish two functions with one lever. Push the lever toward the lens and it stops down aperture; move it the other way and it sets the self-timer. A-series cameras have separate controls for these two functions.

Rotate the Self-Timer Lever to get a delay of about 10 seconds between depressing the shutter button and actual shutter operation. On the A-1 camera, the Self-Timer Lever can be used to select either a 10-second or a 2-second delay.

Stopped-Down Lever—Used to stop down lens aperture either to do stop-down metering or to see depth of field. This lever stops down the lens to whatever aperture you have selected using the Aperture-Control Ring on the lens. Use of the Stopped-Down Lever varies among camera models. See the camera descriptions in Chapter 18.

On-Off Switch—The AE-1 doesn't have this control. You turn on the AE-1 by depressing the shutter button. To turn on the AE-1 metering circuit only and see the exposure display in the viewfinder, use the Exposure Preview Switch.

Other Canon cameras have an On-Off switch, but the location varies. To reduce battery drain, turn the switch off when the camera is not being used. On some models, a third position of the On-Off Switch serves as a battery check.

Film-Rewind Button—Depress to begin rewinding the film after you have exposed the entire cartridge, or any part. After rewinding starts, you don't have to hold the button because it stays in automatically.

Film-Rewind Crank—Tilt up and use to rewind the film after depressing the Film-Rewind Button. The direction to turn—clockwise—is shown by an arrow on the crank.

Flash Hot Shoe—Accepts flash units and triggers the flash automatically using a central synchronization contact in the hot shoe. Some have more than one electrical contact to work with special Canon flash units.

Shutter-Release Button—Depress to operate the shutter and make an exposure. With A-series cameras, the shutter button will not work unless the camera is turned on and it will not work with a dead battery. With other cameras, you can advance film and operate the shutter without turning on the camera electronics because they are only used for light metering.

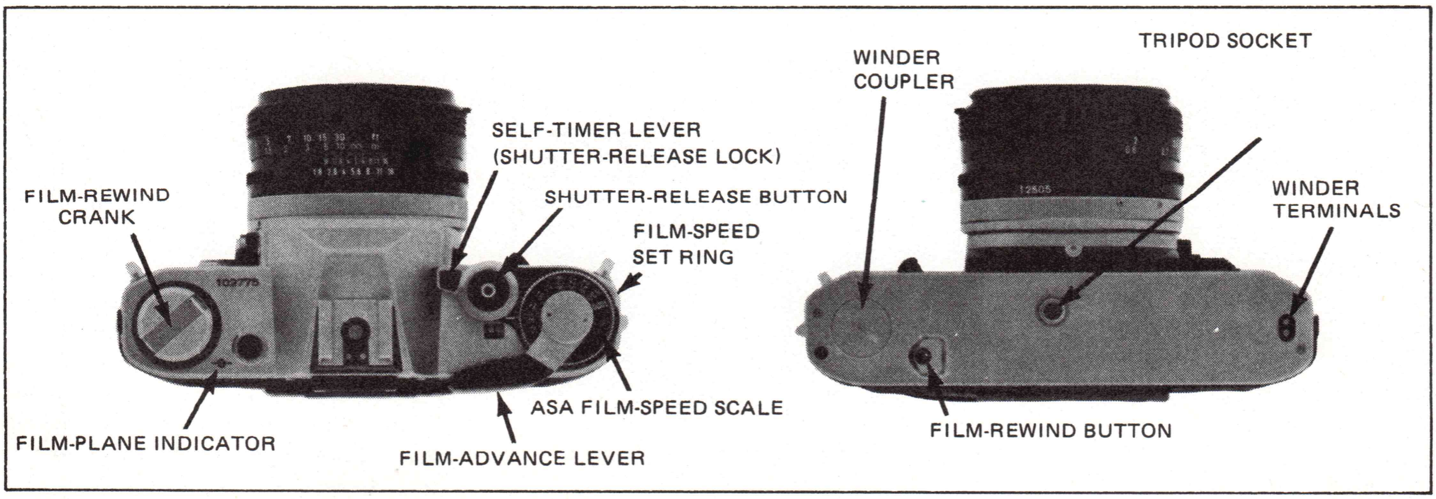
Film-Advance Lever—Hook this lever with your right thumb and rotate it to advance film.

Battery Check Button—Sometimes incorporated in the On-Off Switch. Wherever you find it, operate the battery-check device and it will tell you if the camera battery is OK. Exact procedures are in Chapter 18.

Backlight Control Switch—A way of giving more exposure than the AE-1 would normally give on automatic. Use it for special situations discussed in Chapter 12. The A-1 has a control called Exposure Compensation which is also used to solve special exposure problems.

Shutter-Speed Dial—Turn to select shutter speed. Set the control exactly on a marked number, not between numbers.

Film-Speed Set Ring—Lift the outer ring of the Shutter-Speed Dial and



turn it to select film speed. Read film speed in a window on top of the control.

Film-Plane Indicator—Special mark on top of the camera shows exactly where the film is located inside the camera. Used mainly in photography with special accessories to get high image magnification.

Shutter Lock Lever—On A-series cameras this is combined with the Self-Timer Lever. On other models it is a separate ring around the shutter button. The control has two positions: L locks the shutter button to prevent accidental shutter release. A allows you to operate the shutter. It derives from the word *advance,* meaning *go ahead* or *proceed* to use the camera.

Battery Compartment—Contains the battery used to operate the camera. On A-series cameras, a dead or absent battery disables the camera completely. With other models, you lose metering but some or all shutter speeds are operable and you can use the camera. Batteries tend to fail suddenly and should be replaced annually or more often to be sure your camera works OK. A-series cameras are delivered with a small battery case which fastens to the camera carrying strap. Carry a spare battery and you can always keep shooting when the one in the camera fails.

Memo Holder—Some models have a holder on the back which fits the end of a film carton. After loading the camera, put the end of the carton in the holder to remind you what kind of film you have loaded. This is very handy, particularly if you own two cameras and keep them loaded with different kinds of film.

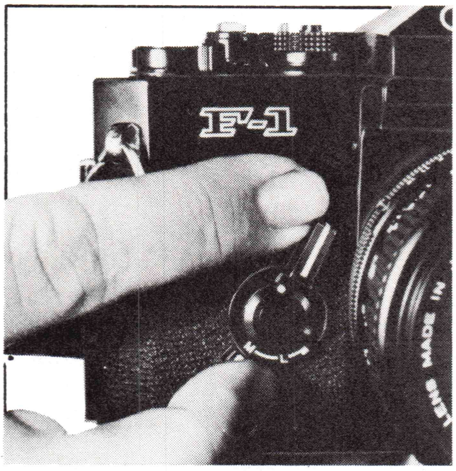
Tripod Socket—A threaded socket used to mount the camera on a tripod. Tripod socket is also used to attach bottom-mounted accessories to the camera—motor drives and power winders.

Winder Terminals and Coupler—Some models mount motor drives or film winders on the bottom. These models are equipped with the necessary electrical and mechanical connections to mount the accessory.

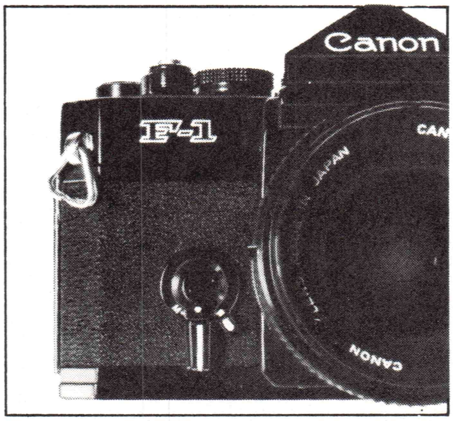
Infrared Index—When shooting with special infrared radiation, use the red dot to the right of the normal distance index rather than the normal index.

The procedure is to focus using visible light, then move the focused distance on the scale to align with the red dot rather than the normal index.

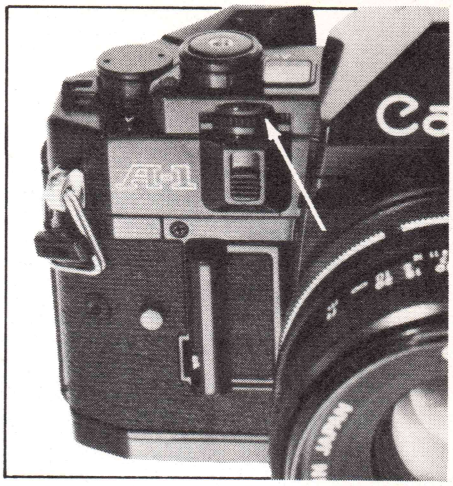
Eyepiece—Viewing window you look through to see the image and the displays in the viewfinder. Frame around the eyepiece is used to attach a variety of special eyepiece accessories such as a magnifier and special lenses to adjust the camera to your vision.



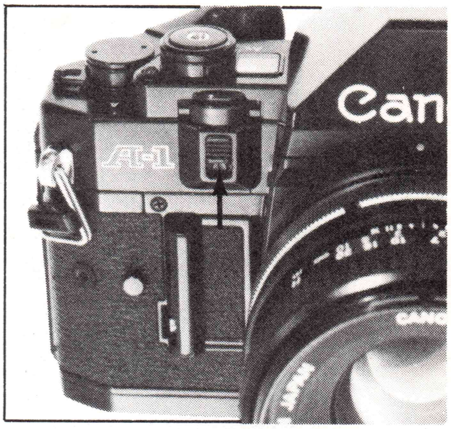
With Stop-Down lever moved toward lens of F-1 or FTb, Lever Lock has two functions. L position stops down lens and locks it that way. M position stops down lens *and* locks up mirror.



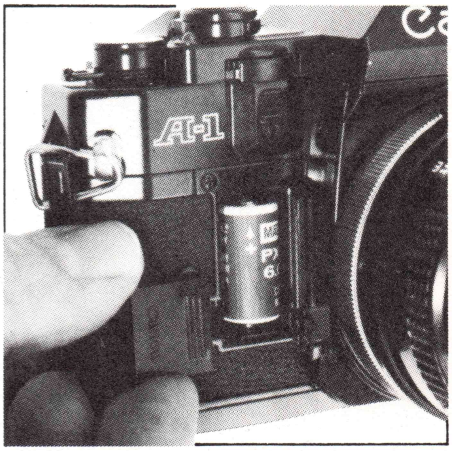
To set the Self-Timer on models with the lever in this location, rotate the lever all the way to the bottom.



On A-1 cameras, the AT Dial is located so you can reach it conveniently with your right forefinger to set aperture size or shutter speed, depending on which camera operating mode you are using.



To prevent accidentally changing the AT Dial setting, A-1 cameras have a movable AT Dial Guard. Slide it up as shown here and it covers the AT Dial.



Battery compartment cover of A-series cameras is hinged near lens and held closed by a catch at the lower left corner. Use the projection on the plastic hot-shoe cover to depress the catch so you can open the compartment.

10
HOW LENSES WORK

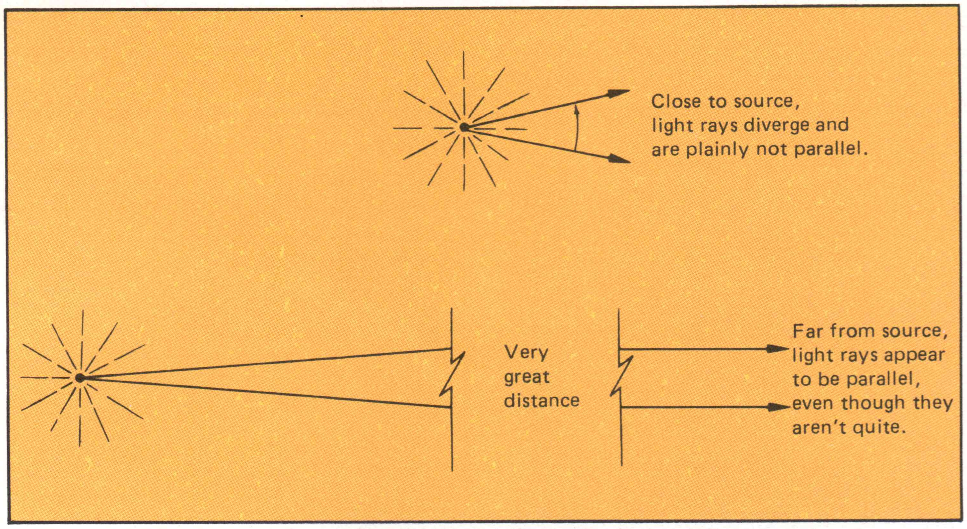

Close to source, light rays diverge and are plainly not parallel.
Very great distance
Far from source, light rays appear to be parallel, even though they aren't quite.

Figure 10-1/Light rays from a point source obviously diverge when you are close to the source. At a great distance, they still diverge, but *appear* to be parallel.

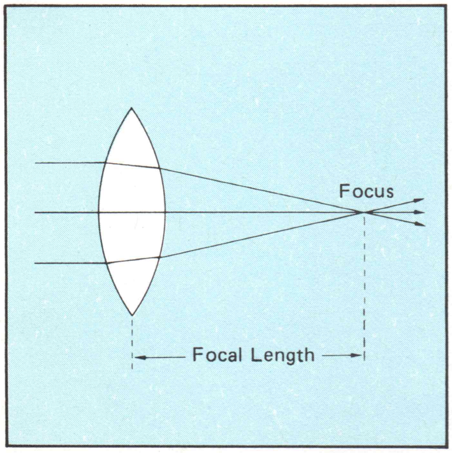

Focus
Focal Length

Figure 10-2/Lenses treat rays which appear parallel as though they actually are parallel and bring them to focus at a distance equal to the focal length of the lens.

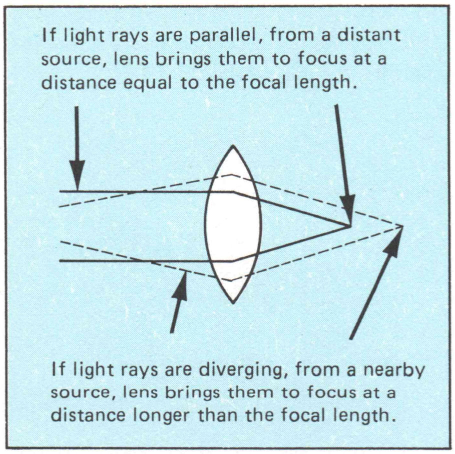

If light rays are parallel, from a distant source, lens brings them to focus at a distance equal to the focal length.
If light rays are diverging, from a nearby source, lens brings them to focus at a distance longer than the focal length.

Figure 10-3/Light rays from a distant source are brought to focus closer to the lens than rays from a nearby source. Because the film plane is a fixed location in the camera, focusing is done by moving *the lens* inward or outward, depending on the distance to the subject.

So far, the discussions of lenses have been either descriptive or practical information on how to attach and remove them. Focal length has been treated as the label which indicates angle of view and magnification. That's all you really need to know to use lenses in normal photography.

Pretty soon, I'm going to discuss some things about close-up and macro photography and for that you need more basic information about how a lens makes an image, types of lenses, and what focal length means in the technical sense. This requires some formulas and simple math but it has a practical payoff in several ways. The most important is in photography with attachments to the camera. Sometimes you have to think your way through a problem that a recipe won't solve.

If you are interested in more information on most of the technical matters discussed in this book, I recommend another book entitled *Understanding Photography* which has impressed me favorably. It is from the same publisher as this book, and by the same author.

LIGHT RAYS

We assume that light travels in straight lines, called *rays* and light rays do not deviate from straight-line paths unless they are acted on by something with optical properties such as a lens or a reflector.

Light rays which originate from a source such as the sun, or which reflect from an object such as a

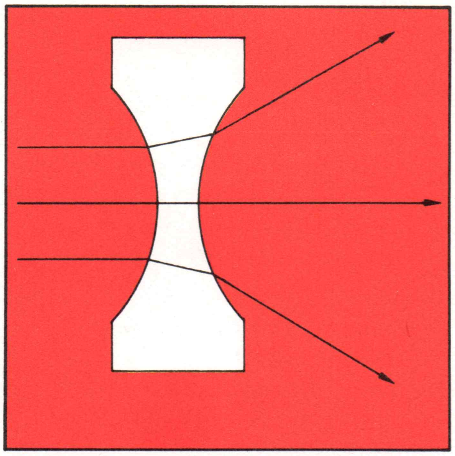


Figure 10-4/A diverging lens causes rays to diverge as they pass through the lens.

mountain, appear to be parallel rays after they have traveled a considerable distance. In explaining how lenses work, the simplest case is when the light rays reaching a lens have travelled far enough to appear parallel as in Figure 10-1.

CONVERGING LENSES

If you photograph a distant mountain, each point on the surface of the mountain reflects light rays as though it is a tiny source of light. The rays which enter the lens of your camera are effectively parallel. Rays from each point of the scene are scattered all over the surface of your lens but all those which came from one point of the scene should be focused at one point on the film. Here's how a lens does that.

Figure 10-2 shows a simple single-element lens which is convex on both sides. This is called a *converging* lens because when light rays pass through, they converge and meet at a point behind the lens.

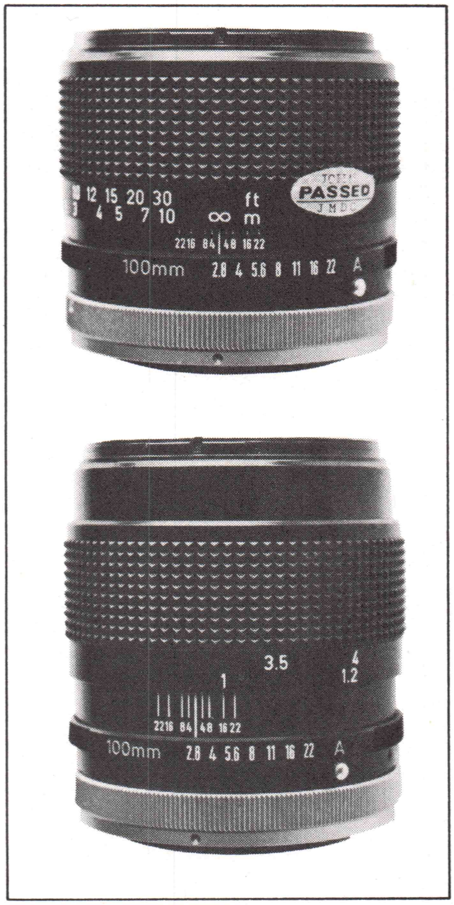
Focal length is defined as the distance behind the lens at which *parallel* light rays will be brought to focus by the lens. That implies a subject which is far enough away from the lens so the light rays appear to be parallel. We label that distance *infinity* on the distance scale of a lens, but it actually doesn't have to be very far away.

For example, the last marked distance on a Canon 50mm lens is 30 feet and the next symbol is ∞, which indicates infinity. Any subject beyond 100 feet or so from this lens appears to be so far away that the light rays from it are effectively parallel.

Because the focal length of a 50mm lens is 50mm, that's how far the lens must be positioned from the film to form a focused image of a distant subject—which we *say* is at infinity even though it may be close enough that we could hit it with a rock.

Figure 10-2 shows what happens to *parallel* rays when they are brought to focus by a converging lens.

This lens will also image subjects closer than infinity, but it takes a greater distance between lens and film to bring nearby subjects into focus.



Most lenses focus by an internal screw thread called a *helicoid.* When changing focus from a distant subject to a nearby subject, most lenses become physically longer to position the lens elements farther from the film.

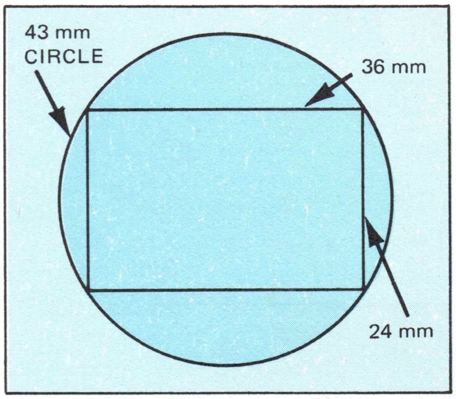
Figure 10-3 shows why. Light rays from a nearby subject appear to diverge as they enter the lens. The lens will still change their paths so they come to focus, but because they were diverging rather than parallel it takes a greater distance behind the lens to bring them all together at a point.

Focusing a camera moves the lens toward or away from the film so there is the needed amount of distance between lens and film. This will bring light rays from the subject into focus at the film, whether the subject is near or far.

Please notice that the *shortest* distance ever required between lens and film occurs when the subject is at infinity and this distance is equal to the focal length of the lens. All subjects nearer than infinity require a longer distance between lens and film. To change focus from a distant subject to something nearby, you move the lens away from the film.

DIVERGING LENSES

Diverging lenses are shaped the opposite way and do the opposite thing. Parallel rays entering a diverging lens emerge on the other side as divergent rays—angled away from each other, shown in Figure 10-4.



The image made by a lens for a 35mm camera is a 43mm circle. The part of the circular image which actually falls on the film is defined by a rectangular window in the camera body, opened and closed by the focal-plane shutter. The dimensions of this window and the film frame are 24mm by 36mm. Exceptions are: The 7.5mm fisheye lens and the TS 35mm lens, both discussed later.

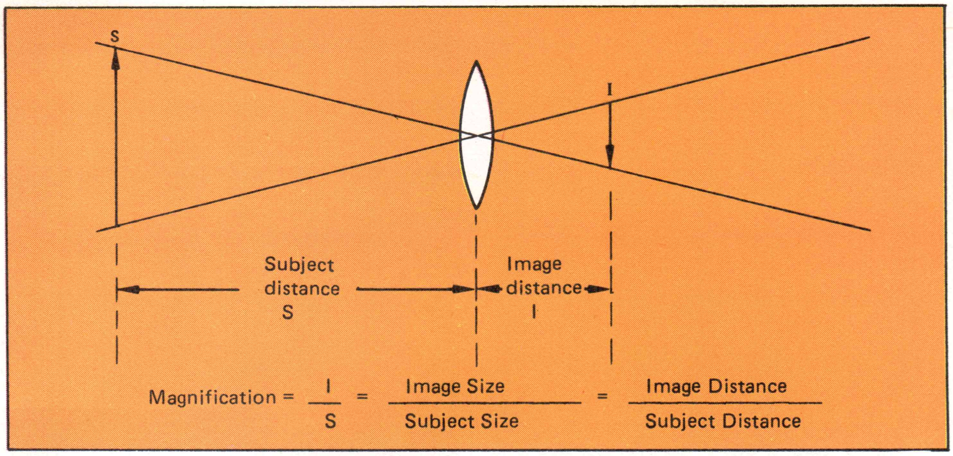

S
I
Subject distance S
Image distance I
Magnification = I/S = Image Size/Subject Size = Image Distance/Subject Distance

Figure 10-5/Because a lens angle of view is the same in both directions, the ratio of image size to subject size is the same as the ratio of their distances from the lens.

FOCUSING A LENS

The focusing ring on the lens operates on an internal screw thread called a *helicoid.* To focus closer to the camera than infinity, the lens travels outward on the screw thread. When the end of the thread is reached, that's as close as you can focus with that lens. With different lenses, the shortest focused distance varies, ranging from inches with short-focal-length lenses to feet with long lenses. There are accessories for focusing a lens closer than its minimum distance, discussed in Chapter 13.

THE IMAGE

A circular lens makes a circular image of a circular portion of the scene. In the camera, a rectangular mask or opening in front of the film allows only part of the circular image to fall on the film.

Even though the camera viewing system shows you an image with correct orientation, the image on the film is upside down and reversed left-to-right.

MAGNIFICATION

Magnification is illustrated with the outside rays of the lens, Figure 10-5, where the subject is an arrow and the image is an upside-down arrow. The arrows extend all the way across the field of view.

Magnification is a ratio or fraction: *The size of the image divided by the size of the subject.*

The angle of view is the same on both sides of the lens. The sizes of image and subject are therefore proportional to their distances from the lens. If image and subject are the same distance from the lens, they will be the same size.

This leads to two ways to think about magnification. You can compare sizes or you can compare distances. Either way, you get the same answer. A simple formula to figure magnification, M, is:

$$M = I/S$$

where I is either image size or image distance from the lens, and S is either subject size or subject distance.

FLATNESS OF FIELD

The film in a camera is flat and held so deliberately. In fact, Canon cameras are very carefully designed to hold the film frame as flat as possible while it is being exposed. Lenses would work better and require less correction if the film were curved in both directions as though it was a section of a sphere. Nobody has figured out how to make and handle film that way, so lenses are corrected for flatness of field. This means that if you photograph a flat surface such as a newspaper, all parts of the image should be in good focus on the flat film in the camera. If not, the lens correction for flatness of field is poor.

This is not of concern in most photography of nature, people and other non-flat objects. In close-up photography, many people copy things like postage stamps. Canon offers the FLM 100mm *f*-4 lens, the FD 100mm *f*-4 Macro, and the FD 50mm *f*-3.5 Macro lens for this purpose with special correction of flatness of field.

FLARE AND GHOST IMAGES

Light arriving at the air-glass surface of a lens is partly reflected at the surface and partly transmitted in the direction we want it to travel. This happens at both surfaces of a piece of glass, so there are internal reflections within a single glass lens element and multiple reflections in a compound lens with several pieces of glass.

In general, any light which is deflected or scattered from its intended path of travel will land somewhere it doesn't belong. This tends to put light on the film where there would otherwise be less light. The stray light has been "robbed" from areas where it should have been. Therefore light areas on the film are not as light as they should be and dark areas are not as dark. The result is a general reduction in contrast between light and dark areas.

If the light which is scattered around by lens reflections forms no definite image on the film but is an overall fog or even a fog over a relatively large area of the picture, we call it *flare.*

Sometimes the reflections from lens surfaces happen in a way that causes a definite shape on the film. Images of this sort are called *ghosts.*

The cure is to reduce light reflection at each glass-air surface which is done by lens coating.

LENS COATING

The first lens-coating method was a single very thin layer of a transparent material such as magnesium fluoride, applied by vacuum deposition.

Canon calls single-coating *Spectra Coated,* abbreviated **S.C.** A single coating layer is most effective at a single color of light.

A more recent development is multiple-layer coating, called by Canon *Super Spectra Coating,* **S.S.C.** This type of coating is effective at more than one color of light and generally superior to a single layer.

LENS ABERRATIONS

To photographers, lens aberrations are like the boogie-man—mysterious, threatening and always lurking around trying to do something bad. Aberrations of a lens cause defects in the image.

There is a long shopping list including spherical aberration, chromatic aberration, coma and astigmatism. All lenses have all of these defects to some degree. Total elimination is probably impossible but partial elimination of these defects, called *correction,* is part of the design of each lens and, for more money you get more correction.

Part of the problem is the fact that the surface of conventional lenses is spherical, mainly for ease of manufacture. Another part of the problem rests in the nature of light and lens glass which does not behave the same with different colors of light—called *chromatic aberration.*

Correction of lens aberrations is done three ways. Basic is the design of the lens itself, using multiple pieces of carefully-shaped glass, called *elements,* to make a complete compound lens assembly in a mechanical housing. This has always involved laborious mathematics. The process has been both speeded and improved by use of modern electronic computers to do the arithmetic.

To correct some of the lens aberrations, glass of differing chemical composition is used for the various elements in the lens. A limitation in the past has been the range of different types of glass.

The chemical fluorite is a transparent crystal found in nature which has certain optical properties which are superior to lens glass. Use of a fluorite element in the lens greatly improves the correction for chromatic aberration.

A way to reduce aberration caused by using spherical lens elements is to use *aspheric*—not spheric—elements in a lens. Canon has lenses in production using aspheric elements.

The manufacture of spherical lenses whose surfaces are "round" has been pretty well standardized. To make an aspheric lens surface, which is not "round" and hold the dimensions of the surface to a few millionths of an inch requires very special manufacturing methods and quality control. Canon aspheric surfaces are glass, not molded plastic, and producing them in quantity is a technical achievement.

As a practical matter, there isn't anything the user can do about the construction and design of a lens except to buy lenses from a reputable manufacturer such as Canon. Canon is a leader in lens design and has won world-wide recognition for the high quality of Canon lenses.

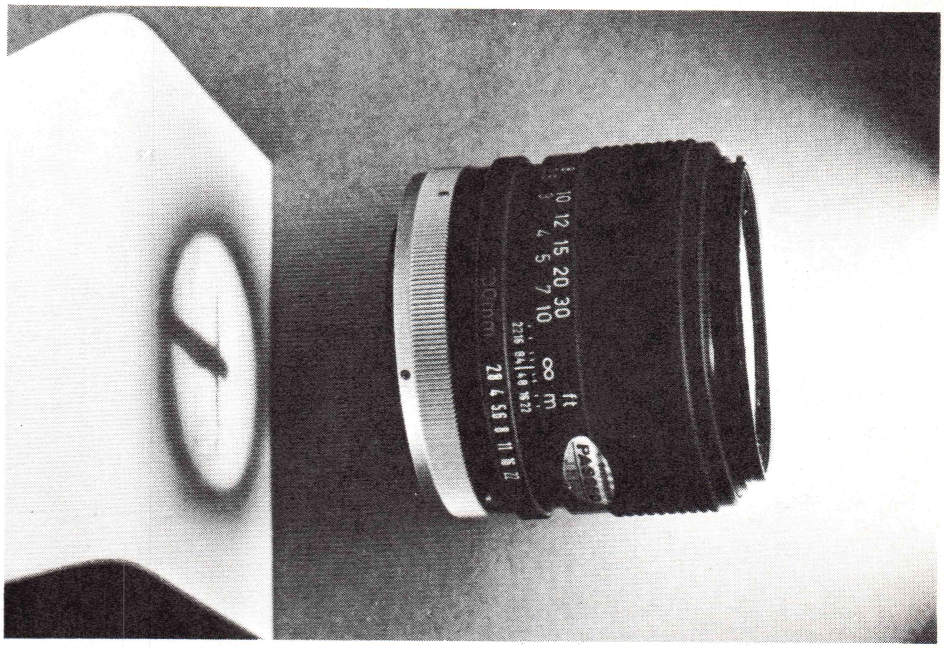
Most lens aberrations have less effect on the image if the lens is used at small aperture. Using ordinary films, it's hard or impossible to see any difference, but theoretically it is better to shoot at an aperture smaller than wide-open.

DIFFRACTION

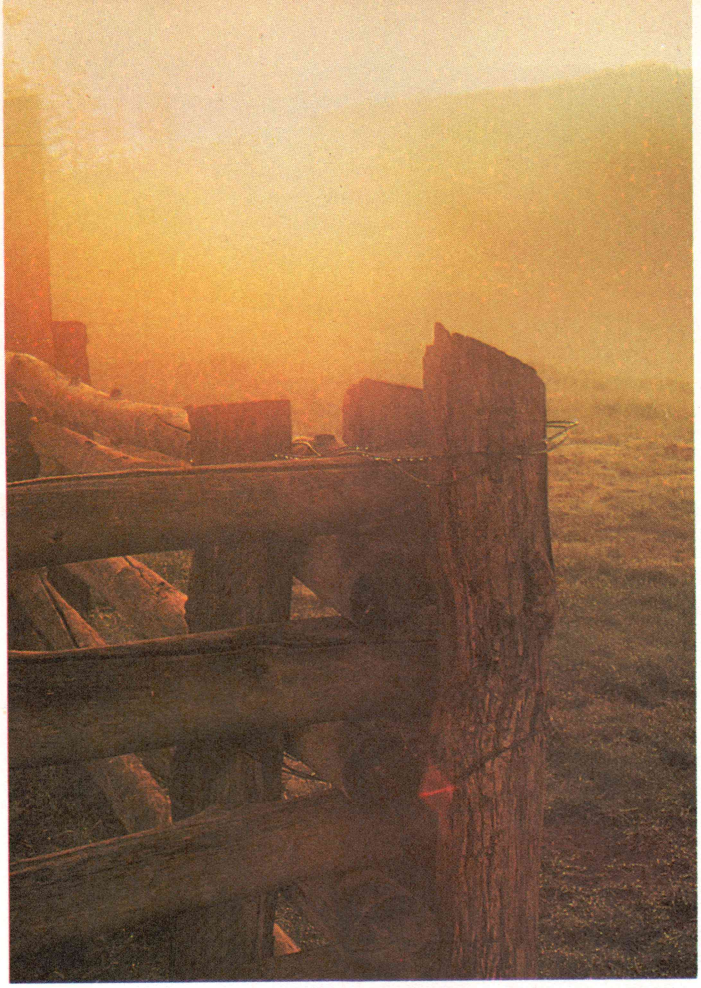
Diffraction happens when a light ray makes grazing contact with an opaque edge such as the lens barrel and the edges of the aperture. Rays which contact the metal edge of the aperture on their way into the camera are changed in direction slightly, bending toward the metal edge. Also, a pattern of alternating light and dark bands of light is formed.

Light rays from any point of a scene should converge to a point-image on the film. Because of diffraction, some of the rays will be diverted and the image will be spread out. Only those rays which pass very close to the edge of the aperture are affected—those which go through the center of the lens are not diffracted.

Therefore the amount of image degradation due to diffraction depends on what proportion of the rays graze by the edge of the aperture and what proportion pass through the center part of the hole.



Lenses form an upside-down reversed image of the subject. The distance from lens to image is measured from a location in the optical path called a *node.*



Ghost images are unpredictable. Shooting into the morning sun caused one near the bottom of this picture.

Macro lenses are designed to allow closer than normal focusing so you can get pictures like this.

As an aperture is made smaller, there is more edge and less center area, so the total percentage of rays which are diffracted by the edge is higher.

OPTIMUM SHOOTING APERTURE

If a lens is scientifically tested for image quality, starting at maximum aperture, the image will improve at successive *f*-stops as the lens aperture is closed because the effect of aberrations is reduced. It varies among lenses, but typically at around *f*-5.6 or *f*-8 the image is as sharp as it's going to get. Further reductions in aperture size cause diffraction effects to degrade the image. This degradation is gradual and even at *f*-22 it is unusual to identify diffraction effects with the unaided eye.

Usually there are other compelling reasons which determine aperture size, but if you have none and you want the best image, set the lens at an *f*-stop near the center of its range.

LENS NODES

As you remember, the technical definition of focal length is the distance from lens to film when the lens is focused at infinity. All ordinary photography can be done with complete satisfaction without even knowing that!

All lenses mount on the camera the same way and at the same place, so you may wonder how a long-focal-length lens finds additional room behind the lens to make the image.

Image distances are not tiny. As a rule of thumb, 25mm equals one inch. A 50mm lens needs about 2 inches between lens and film. A 200mm lens needs about 8 inches behind the lens to make a focused image.

Each lens of different focal length does have the correct distance between lens and film when mounted on the camera, but it's done optically rather than mechanically. There is a point in the optical path from which the distance to the film is figured. This point is called a *node,* and it's location is controlled by the optical design of the lens rather than its mechanical construction. To get a longer *optical* distance between lens and film, the node is moved forward by scientific trickery. You can't see a node and you can't find it to measure from, but it's there. You can always assume that the *optical* distance between lens node and film is equal to the focal length of the lens—when the lens is focused at infinity.

TELEPHOTO LENSES

The basic requirement to make a

long-focal-length lens is to have a relatively long distance between the lens and the film. This can be done in a clever way by using a diverging lens element in the lens as shown in Figure 10-6.

The first lens converges the rays so they would come in focus as shown by the dotted lines. Before reaching the film, the converging rays are intercepted by the diverging lens element which causes them to converge at a greater distance as shown by the solid lines.

Lenses built this way are called *telephoto* although the word has come to mean any long lens in popular language. The telephoto principle has two advantages. A lens can be physically shorter than it would be without the diverging element. The node can be located where it needs to be so the focused image lands on the film plane in the camera body.

Telephoto lenses can be identified by looking into the front and back of the lens while holding it away from your eye and pointing it toward a window. At each end of the lens you will see a spot of light, called the *pupil,* which is actually the lens aperture seen through that end of the lens.

With a conventional lens, the two pupils will be the same size or nearly so. With a telephoto lens, the pupil seen looking in the front will be plainly larger than the pupil seen looking in the back.

If you change aperture while looking at a pupil, you will see the size of the pupil change also. This is a factor in through-the-lens metering systems which will be discussed later.

RETROFOCUS LENSES

The telephoto design can be used to move the lens node forward so there is enough space between the node and the film plane to accommodate a long focal length.

The problem is reversed with very short focal-length lenses. For example, a 24mm lens has a rear focal length of about one inch. The distance between the lens mounting surface and the film plane on Canon camera bodies is about 1.5 inch. A conventionally-designed 24mm lens would make a focused image about one-half inch in front of the film plane in the camera—with the lens set at infinity.

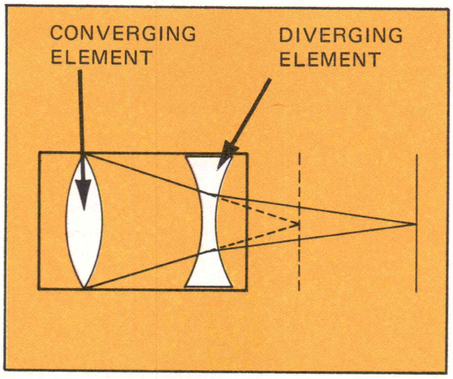


Figure 10-6/Telephoto lenses use a diverging lens element which increases the lens-to-film distance and gives a longer focal length.

Light can go through a lens in either direction and lenses can be used when reversed front-to-back. The design principle of the telephoto lens can be reversed to move the lens node toward the film plane rather than away from it. A *reversed telephoto* lens design is often called a *retrofocus* lens. The design is used primarily to fit a short focal-length lens onto a camera body whose dimension between lens mount and film is longer than the focal length of the lens. It moves the node closer to the film.

With a retrofocus lens, the pupils are not the same size either—the rear pupil is bigger than the front.

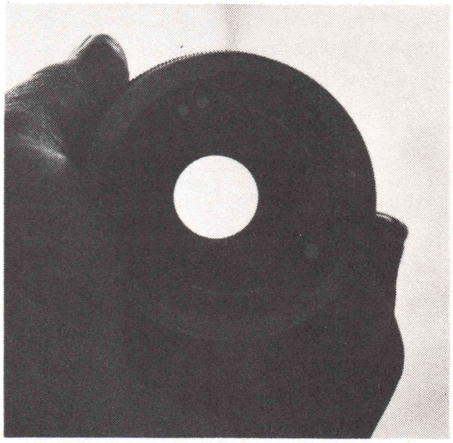
TELE-EXTENDERS

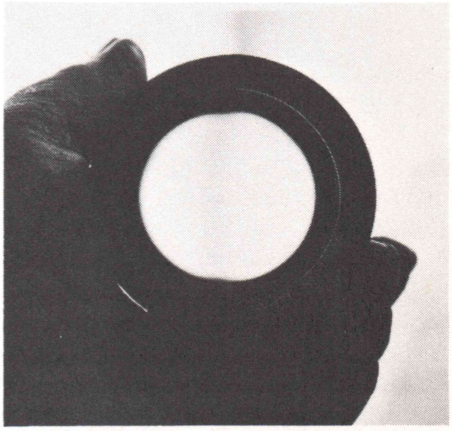
Accessory lenses called *tele-extenders* fit between a camera lens and the camera body. Tele-extenders are diverging lenses placed in the optical path between a lens and the camera to give the same effect as the diverging lens in a telephoto design. The focal length of the lens and tele-extender combined is longer than the focal length of the lens alone.

Tele-extenders usually come in two types marked 2X and 3X. The identification number is also the focal-length multiplier. A 2X tele-extender used with a 50mm lens gives it an effective focal length of 100mm. A 3X tele-extender with a 200mm lens makes it act like a 600mm lens.

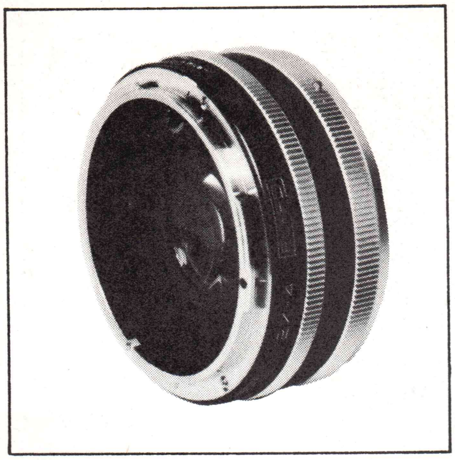
Because the main lens and the tele-extender are not designed as a unit, correction of lens aberrations for the two used together is not as good as a well-designed telephoto lens all in one unit. However tele-extenders are an economical way to get more focal lengths. You must decide if image quality is satisfactory for your purpose.

Another disadvantage of tele-extenders is they also multiply the effective *f*-number of the lens. An *f*-1.4 lens used with a 2X tele-extender behaves like an *f*-2.8 lens

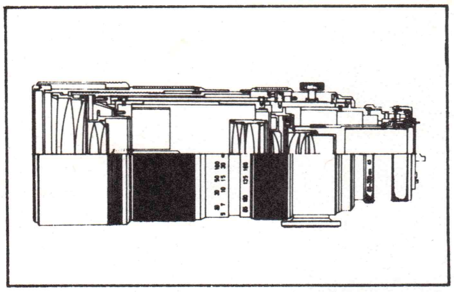




If the disc of light seen looking into the front of a lens is considerably larger than the disc seen from the back, it's a telephoto lens.



Among Canon tele-extenders, a 2X is sold with the FL-F 300mm *f*-2.8 lens and a different 2X is sold with the FD-F 300mm *f*-2.8 lens. These are intended only for the lens with which they are sold.



All lenses are optically and mechanically complex, but zoom lenses are more so. This is a cutaway view of the FD85-300mm *f*-4.5 zoom lens.

and you lose two stops.

Canon makes a 200mm *f*-4 lens. Used with a 2X tele-extender it behaves like a 400mm *f*-8 lens—pretty slow! For reasons you will read about in the next chapter, at an effective aperture of *f*-8, the microprism focusing device in the camera viewfinder won't work.

Canon doesn't offer tele-extenders except for designated lenses because the lens and its special tele-extender are designed to work together optically. Canon does not recommend use of these special tele-extenders with any other lens.

To preserve camera automation, an accessory tele-extender must couple with the pins and levers in the back of the lens and transmit mechanical movements accurately between lens and camera body.

Canon doesn't officially discourage use of accessories not of their manufacture; neither do they encourage it, which is understandable.

If you decide to use accessory tele-extenders, you'll get less image degradation with medium telephoto lenses such as 100mm and 200mm than with lenses of other focal lengths. A 2X will give better results than a 3X.

If your equipment works fine without an accessory but doesn't work well with the accessory installed, suspect the accessory unit first! Naturally Canon cannot guarantee that other manufacturer's equipment will function acceptably when used as part of the Canon system.

ZOOM LENSES

All I will attempt to do here is give you the general idea of what happens inside a zoom lens. As you probably know, these lenses can be focused on a subject and then by a separate control the lens focal length can be changed to alter the magnification and the size of the image on the film.

If you will please refer back to Figure 10-6, which shows how a diverging lens alters the focal length of a converging lens, it will be apparent that the distance between the converging and diverging lens controls the focal length of the combination.

Zoom lenses are complex, using many glass elements in a mechanical assembly which requires high precision and extremely close manufacturing tolerances. They work by moving lens elements inside the lens tube to alter focal length. It would be ideal if nothing changed except focal length when zooming the lens. Focus on the film should remain sharp while image size changes; the *f*-number of the lens should remain constant; and aberrations should not increase.

In practice this is difficult to accomplish. A lens design can preserve good focus at one or more points along the zoom range, but it is difficult to keep sharpest focus at all focal lengths. Focus a zoom at its longest focal length where depth of field will be smallest and, therefore, the focus adjustment will usually be more accurate. Then zoom to shorter focal lengths.

If you do it the other way, you can miss exact focus slightly when starting at a short focal length, because of the greater depth of field available. Then when you zoom to a longer focal length and get less depth of field, your subject may be outside the zone of critical focus.

It would be ideal to have a zoom lens with a zoom range from zero to infinity but practical limitations restrict the range so lenses usually zoom in the medium focal lengths such as 35mm to 70mm, or in the longer focal lengths such as 100mm to 200mm or 85mm to 300mm.

MACRO LENSES

Macro means photography at magnifications of 1.0 or greater. Close-up photography includes magnifications from 0.1 up to 1.0. The dividing point—a magnification equal to 1.0—is called *life-size.*

Conventional lenses are corrected for aberrations on the assumption that the subject distance will be considerably longer than the image distance. At magnifications greater than 1.0, image distance is longer than subject distance. Conventional lenses work better if physically reversed on the camera to keep the long dimension on the same side of the lens even though that long dimension becomes image distance.

Canon supplies reverse-mounting rings to attach lenses backwards. The loss of camera automation when this is done is usually not a major problem.

Because of increasing interest in close-up and macro photography, Canon has developed special lenses for this purpose, described in Chapter 14.

MIRROR LENSES

Mirror lenses have curved mirrors inside to reflect light rays. Because of the mirrors, light travels in two directions inside the lens to reduce physical length of the tube. Mirror lenses are normally made only in long focal lengths.

Canon has developed and produced mirror lenses for industrial and scientific use but they are generally not applicable to ordinary photography. The 5,400mm *f*-14 mirror lens, as an example, is transported in a truck! Disadvantages of mirror lenses are: Fixed aperture requires use of light-reducing (neutral-density) filters to adjust exposure. A peculiar form of image distortion sometimes reproduces bright points of light from the scene as circles of light on the image, especially points which are out of focus. The image is usually not as sharp as obtained with telephoto designs.

TILT AND SHIFT LENS

The Canon TS 35mm *f*-2.8 S.S.C. lens is a very unusual design for 35mm cameras. The TS in the lens nomenclature means Tilt and Shift, language borrowed from view cameras. You may have seen view or technical cameras with a bellows between the lens and the film holder and a variety of adjustments to put lens and film at crazy-looking angles in respect to each other.

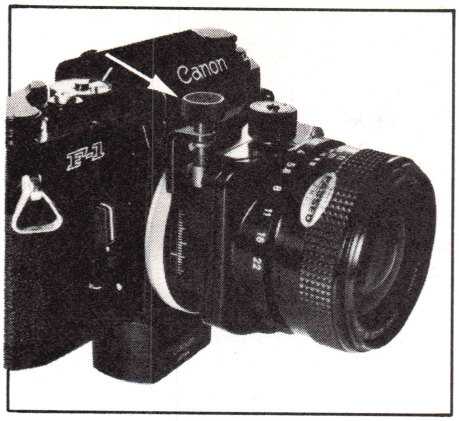
View-camera adjustments are useful to photograph architecture and to maintain good focus along a subject, such as a wall which angles in respect to the film plane. The TS lens doesn't have the flexibility of a view camera, but it comes close. The lens can be moved up and down, or sideways, while remaining parallel to the film, which is called *shift.* It can also be *tilted* so it is no longer parallel to the film plane.

The basic requirement for any lens in any camera to do these tricks is that the image circle made at the film plane be considerably larger than the frame on the film.

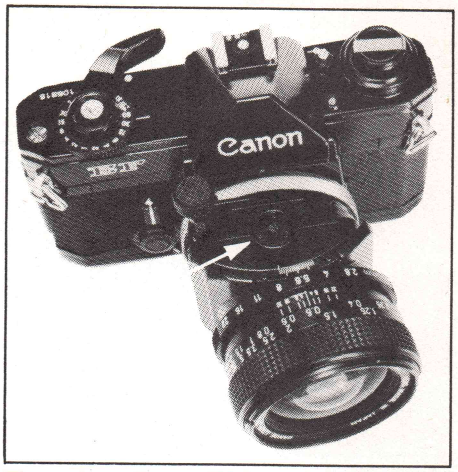
Any lens for a 35mm camera has to cover a 43mm circle—the diagonal of the film frame—with good focus and even illumination. The TS lens makes an image circle about 1/3 larger, covering 58mm in diameter.

This is like good news and bad news. The bad news is you can't get all of that image on the film. The good news is you can get any part of it you want, within limits. This allows photographing tall buildings without the building seeming to get narrower as it gets higher. You get rid of the illusion that it is falling over backwards.

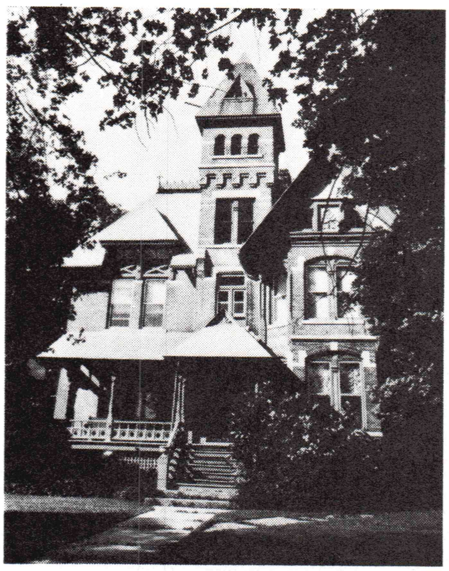
To photograph buildings without the perspective-effect of falling over backwards you must keep the plane of the film parallel with the face of the building. A good way to judge this is to compare the lines made by the sides of a building with the lines made by the sides of the viewfinder. If they are parallel, the building



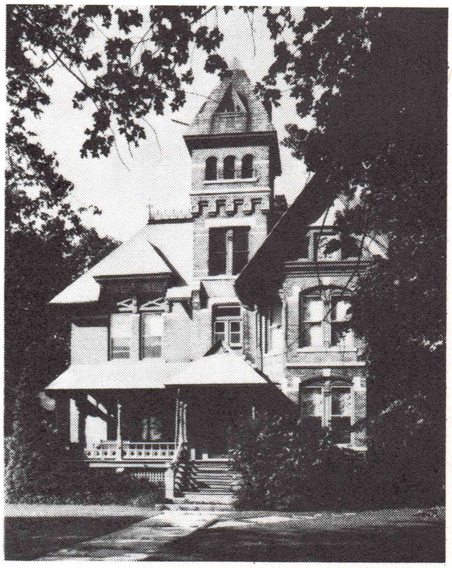
The Canon TS 35mm *f*-2.8 S.S.C. lens solves a lot of photographic problems. It is shifted by the screw adjuster (arrow) and the amount of shift is indicated by the scale on the side.



The unique Canon TS lens also tilts so the lens points off-axis. Knob at the center (arrow) does the tilting as indicated by the adjacent scale. The tilt adjustment is locked by a knob on the bottom of the lens.



Here's one of the problems the TS lens can solve. If you point the camera upward to get all of the building, it seems to be leaning backward. Sometimes the effect is subtle.



Hold the camera so the film is parallel to the building, shift the TS lens upward, and you get the shot without the peculiar "leaning backward" effect.

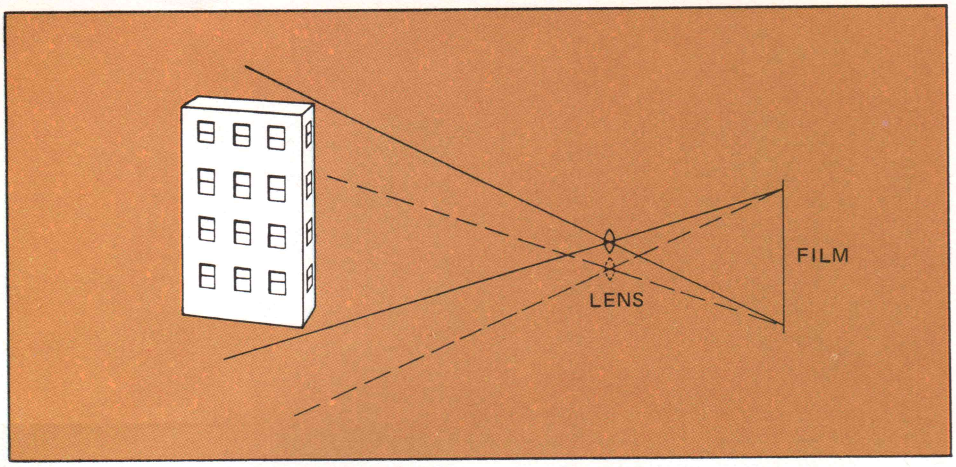


Figure 10-7/Shifting the lens upward changes the part of the scene which falls on the film.

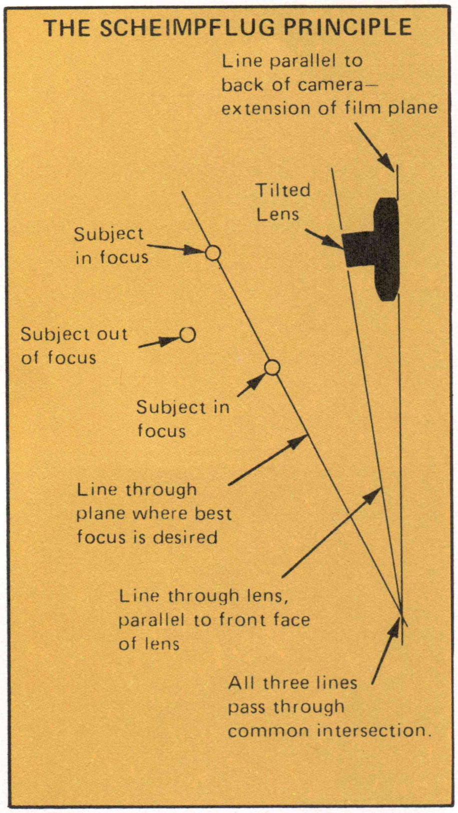

THE SCHEIMPFLUG PRINCIPLE
Line parallel to back of camera—extension of film plane
Tilted Lens
Subject in focus
Subject out of focus
Subject in focus
Line through plane where best focus is desired
Line through lens, parallel to front face of lens
All three lines pass through common intersection.

Figure 10-8/To figure which way to tilt, imagine you are looking from above at the camera and scene. Imagine a line extending from the film plane, a line through the lens parallel to the front face, and a third line through the scene which passes along the plane where best focus is desired. Arrange camera position and lens tilt so all three of these lines intersect at the same point. Make final adjustments by looking through the viewfinder.

will record on film with uniform width from top to bottom.

With an ordinary camera used at ground level and not aimed upward for the reason just mentioned, the tall building looks fine but you only get the lower few floors and most of the parking lot. You can move back to get more building in the picture and you also get more parking lot.

Figure 10-7 is a drawing commonly used to show how shifting the lens helps. Notice that the film is parallel to the building. With the lens in normal position on the camera, the view is shown by dotted lines—part of the building and some of the parking lot.

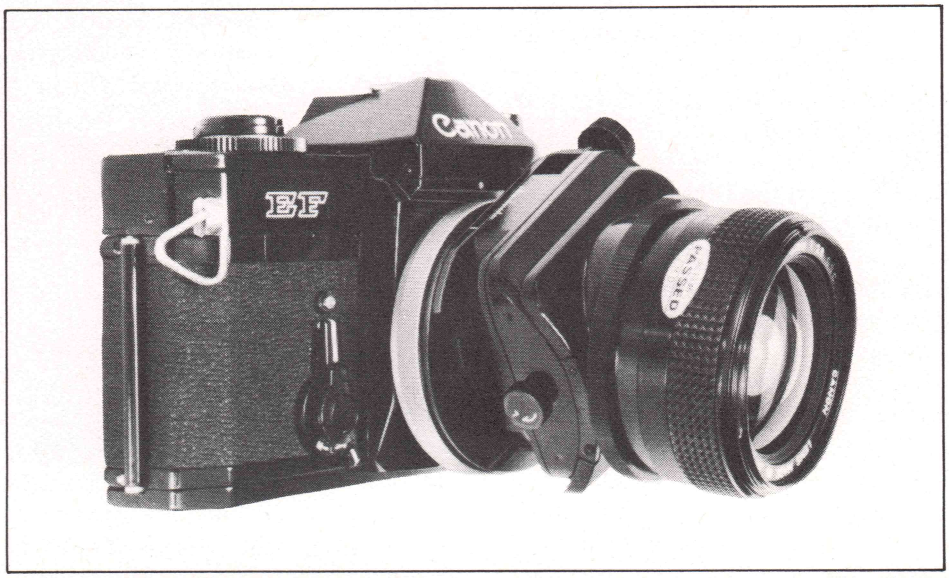
To include the top of the building in the photo, the lens is moved upward as shown by the solid lines in the drawing. Now the photo includes the top of the building and less foreground.

The TS lens has a screw adjustment to allow shifting the lens so you can hold the film plane parallel to buildings and also control the amount of building in the picture.

In addition to the *shift* feature, you can also *tilt* the lens in respect to the film plane. The entire lens can be rotated in its mount to allow shifting vertically, horizontally, or any direction in between. If the lens is positioned so the shift movement is vertical, then the tilt movement is side-to-side, or left-to-right.

The purpose of tilting a lens is to hold focus on a surface—such as a wall—at an angle to the film. Because of the angle between wall and film, the distance to different parts of the wall is not the same. With an ordinary lens, the only thing that helps keep all parts of the wall in focus is depth of field. If depth of field isn't enough, some of the wall goes out of focus.

Tilting the lens in respect to the film improves focus along an angled wall or fence by using the well-known *Scheimpflug* principle, illustrated in Figure 10-8. It's pretty heavy with optical theory, but it



The TS lens rotates in its mount so you can tilt and shift vertically, horizontally, or any angle in between. Knob visible on bottom is tilt adjuster lock.

shows what to do in practice with a tilting lens.

Canon TS lens adjustments allow shifting and tilting simultaneously, with separate controls for each. When looking through the viewfinder, the effect of shift is obvious and easy to see—the whole scene moves in the viewfinder. The effect of tilt is more subtle and often much more apparent in the developed slide or print. The best way to become familiar with lens-tilt effects is to shoot some pictures and examine the results.

HYPERFOCAL DISTANCE

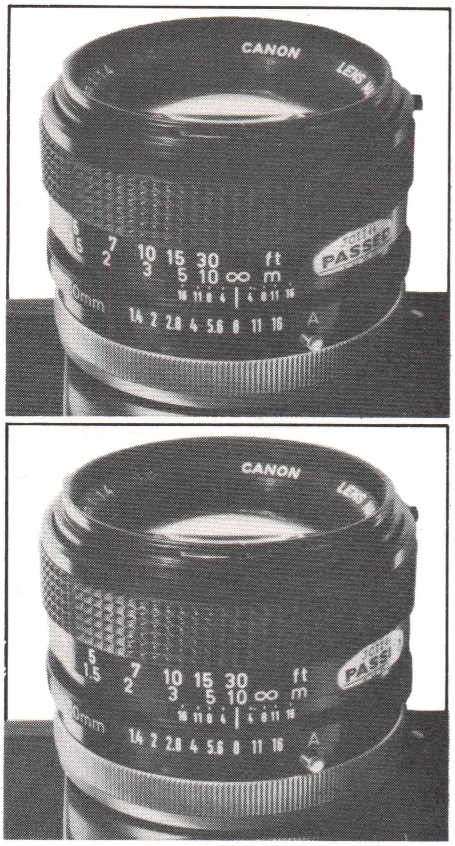
Just as the discovery of our friend Scheimpflug leads to practical information you can use, so also does the optical designer's term *hyperfocal distance.*

If you focus a lens at infinity it still has some depth of field in both directions from the focused distance. However, that part which extends *beyond* infinity is wasted because nobody lives there.

When focused at the hyperfocal distance, the lens has more total depth of field than at any other setting of the focus control. Therefore focusing at the hyperfocal distance is a very good way to set the camera when you are carrying it around. Then, if something happens suddenly and you want to shoot as fast as possible, you have a very good chance of getting the picture without fooling around with focus.

Finding the hyperfocal distance is easy because it is just the near limit of depth of field, when the lens is set for infinity. You read it off the lens. It will vary with *f*-stop, but the depth of field indicator on the lens takes care of that problem.

Set the lens to infinity and notice the near limit of depth of field, at the aperture you intend to use. Then refocus to that distance.



Top lens is focused at infinity and set at *f*-8. Depth of field starts at *10 meters* and goes beyond infinity. Refocus the lens to 10 meters which is the hyperfocal distance (H) for *f*-8.

In the bottom picture, depth of field now extends from 5 meters to infinity and none is wasted. When focused at H, near limit of depth of field is always half H. Far limit is always infinity. This setting always gives maximum depth of field for any *f*-stop.

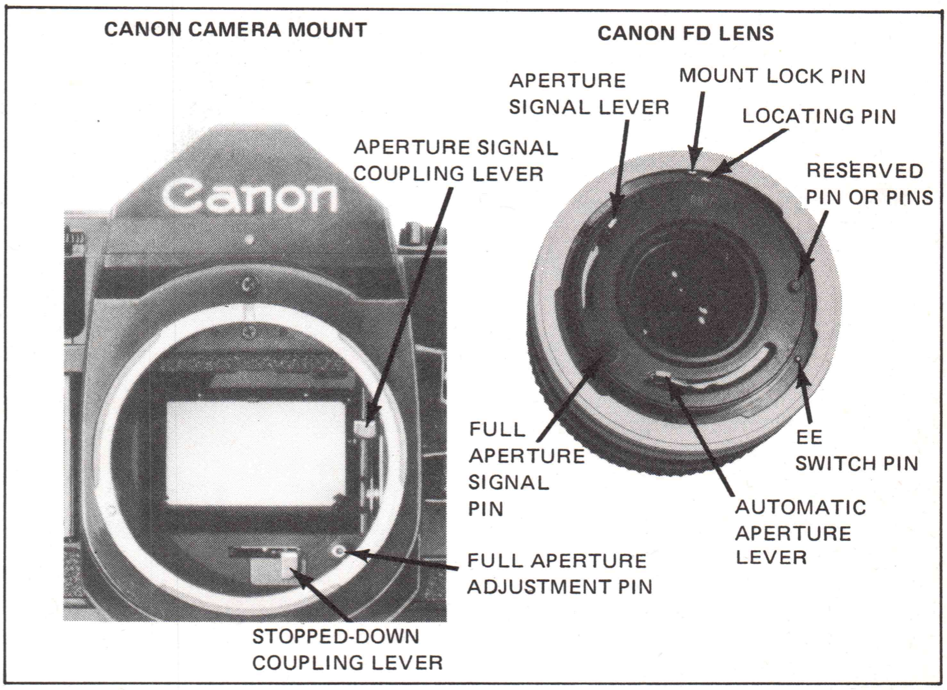
HOW FD LENS AND CAMERA WORK TOGETHER

As you remember, the FD lens type has all necessary pins and levers to allow full-aperture metering and automatic aperture operation by the camera. It also works wih automatic cameras so the camera can set lens aperture, and it does some other tricks.

The way the levers on the lens are used by the different camera models is important because it affects both stopped-down metering and stopped-down viewing to see depth of field.

In the accompanying photos, you see the front of the camera body and the back of an FD lens. Three signaling devices affect stopping down and metering:

LENS	CAMERA
Aperture Signal Lever	Aperture Signal Coupling Lever
Full Aperture Signal Pin	Full Aperture Adjustment Pin
Automatic Aperture Lever	Stopped-Down Coupling Lever



Pins and levers on camera body and lens work together to provide the automatic features of an FD lens.

The Automatic-Aperture Feature—When the lens is mounted on the camera, the Automatic Aperture Lever on the lens is just left of the Stopped-Down Coupling Lever on the camera. When you depress the shutter button on the camera, th Stopped-Down Coupling Lever moves to the left (in the photo) and pushes the Automatic Aperture Lever on the lens to the side and upward in a curved slot. This movement of the Automatic Aperture Lever causes the lens aperture to stop down to any *f*-number you selected on the lens aperture-control ring.

On the camera body is a control called Stop-Down Lever that you use for two purposes. If you intend to meter stopped-down, operate the lever. If you wish to view depth of field with the lens stopped down, operate the lever. In both cases, th Stopped-Down Coupling Lever in the camera will move the Automatic Aperture Lever on the lens to stop down aperture.

To Disable Automatic Aperture—The *only* way to cause an FD lens to stop down is to move the Automatic Aperture Lever to the right (in the photo). If you want the lens to operate with *manual* control of aperture, use your finger to push the Automatic Aperture Lever fully to the right. When it reaches the end of the slot it will remain there. Then the aperture will change size as you rotate the aperture-control ring on the lens. To put the lens back on automatic aperture, push the Automatic Aperture Lever fully to the left in its slot.

Full-Aperture Metering—This uses the Aperture Signal Lever and the Full Aperture Signal Pin on the lens. Only FD lenses have these two devices.

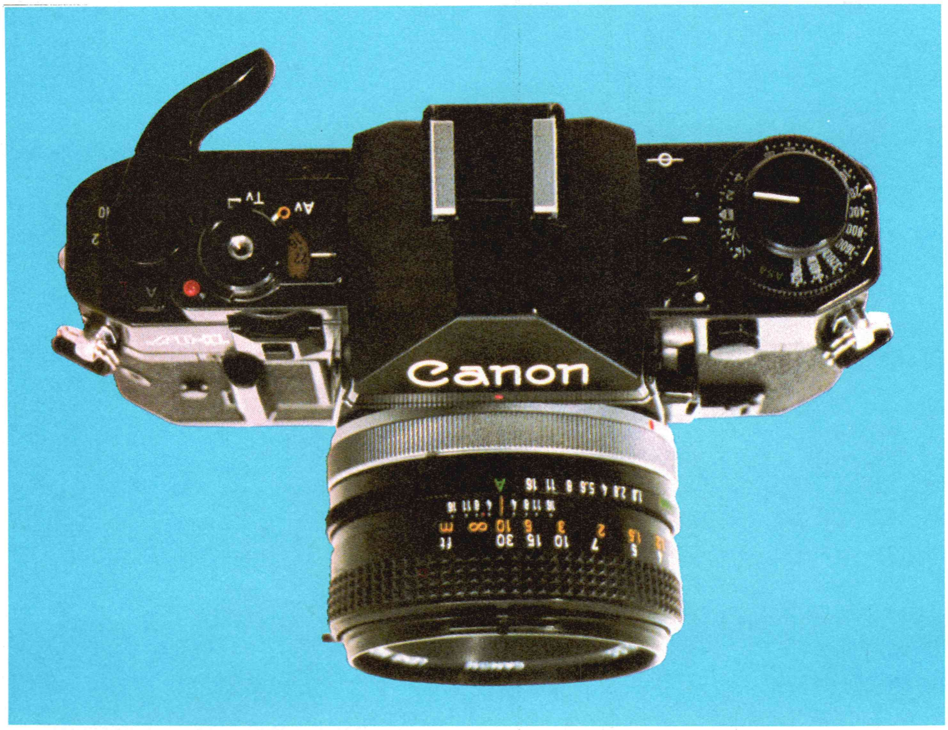
To meter at full aperture, the camera needs to "know" two things: the maximum aperture of the lens and how many steps you have rotated the aperture-control ring away from its maximum-aperture setting.

When you are choosing an aperture size by rotating the aperture-control ring on the lens, the Aperture Signal Lever on the back of the lens moves up and down to signal how many steps the setting is away from full aperture. The camera receives this signal because the Aperture Signal Coupling Lever on the camera fits just beneath the Aperture Signal Lever on the Lens—so they move up and down together.

At the same time, the Full Aperture Signal Pin on the lens presses against the Full Aperture Adjustment Pin in the camera. The pin on the lens is made to a different length for different maximum aperture values. As it moves the Full Aperture Adjustment Pin in the camera, it "tells" the camera the maximum aperture of the lens you have installed. Lenses and accessories that have an Aperture Signal Lever and a Full Aperture Signal Pin so they can do full-aperture metering are sometimes called *meter-coupled.*

Setting an FD Lens for Automatic Exposure—On all Canon SLR cameras with automatic exposure capability, the control that selects automatic or manual is the aperture-control ring on the lens. At the extreme right end of the scale of aperture numbers is a green letter A, for automatic. On older lenses it is a green O. To select automatic operation, rotate the aperture-control ring until the A or O is opposite the index mark. Some lenses have a pushbutton near the aperture scale called EE Lock Pin. You must depress this pin to set the lens to A, or turn it away from the A setting to select aperture manually.

When set to automatic, a tiny metal EE Switch Pin projects from the lens mounting surface on the back of the lens. Cameras with automatic-exposure capability have a matching hole in the lens mount; non-automatic cameras do not have the hole. Therefore if the lens is set to A, the pin projects and you



To set an FD lens *and the camera* for automatic operation, rotate the lens aperture-control ring so the green letter A aligns with the index mark as shown. Recent FD lenses have a small pushbutton near the A symbol that you must depress to select A or to move the control away from A. Some early FD lenses were engraved with a green O rather than A.

With cameras such as the AT-1 which do not have automatic capability, you cannot rotate the lens to A and you cannot even mount the lens if set to A.

can mount the lens only on automatic cameras. If the lens is not set to A, the pin does not project and you can mount the lens on any Canon SLR. Once the lens is mounted, you can only turn the lens to A if it is mounted on an automatic camera with the hole for the EE Switch Pin.

Controlling Lens Aperture Automatically—When the aperture-contorl ring on an FD lens is set to A, the function of the Aperture Signal Lever changes. With manual aperture control, this lever moves up and down as you rotate the lens aperture-control ring to signal lens aperture settings to the camera. This lever is spring-loaded so it always moves downward as far as it can. If it is completely free to move, it will travel to the bottom of the slot.

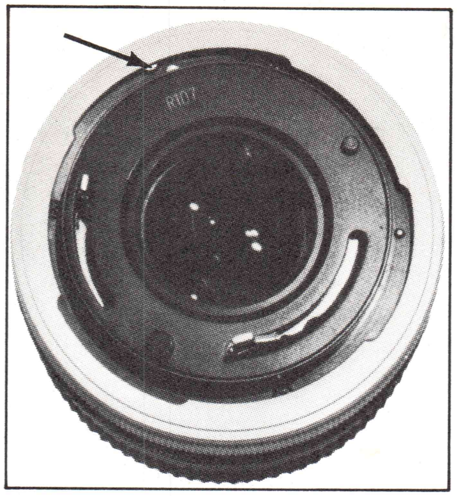
When the lens is set to A, the Aperture Signal Lever on the lens is mechanically disconnected from the aperture-control ring and moves downward as far as it can. Its function then is to *receive a command* from the camera, so the camera controls aperture size. This is done in several ways.

AUTOMATIC APERTURE WITH THE F-1

The F-1 controls aperture automatically when the accessory Servo EE Finder is installed. The control arm of the finder lifts up the Aperture Signal Lever on the lens to a position that will give correct exposue when the aperture stops down.

When the camera shutter button is operated, the Stopped-Down Coupling Lever in the camera moves the Automatic Aperture Lever on the lens, causing lens aperture to close down to the value selected by the position of the Aperture Signal Lever.

The Aperture Signal Lever is positioned by the Servo EE Finder at the time exposure is measured, rather than later when the shutter operates. Therefore you can view depth of field any time after exposure measurement just by pushing in the Stop-Down Lever on the camera. Because the Aperture Signal Lever is positioned correctly for the next exposure, you will see depth of field at shooting aperture.



When you rotate the Breech-Lock Ring counterclockwise to remove a lens, it locks in that position to make it easy to remount the lens. If you want to move the levers and the aperture-control ring to see how the lens works on the camera, you must first rotate the Breech-Lock Ring clockwise as though the lens was mounted on the camera. To do this, use any small pointed instrument to depress the Mount Lock Pin (arrow) while rotating the ring. When you install the lens, this pin is automatically depressed by the camera mount. Some early FD lenses do not have the locking feature and do not have the Mount Lock pin.

In all cases, the bottom position of the Aperture Signal Lever on the lens corresponds to the smallest aperture size. If the lens is under manual control, rotating the lens aperture-control ring from maximum aperture size to minimum aperture size causes the Aperture Signal Lever to move from top to bottom. In automatic operation, when an automatic camera lifts the Aperture Signal Lever upwards, it is selecting larger aperture size.

AUTOMATIC APERTURE WITH THE EF

On automatic, the EF also works by lifting up the Aperture Signal Lever on the lens. The EF does it with spring power, rather than battery power. When you advance film, the mechanical motion winds up a spring in the camera. During metering, the camera decides what aperture it will use, but it does not move the Aperture Signal Lever on the lens until after you depress the shutter button. Then the spring in the camera lifts up the Aperture Signal Lever on the lens to the correct position for the desired aperture. Then the Stopped-Down Coupling Lever in the camera moves the Automatic Aperture Lever on the lens so aperture is stopped down.

Until this happens, the Aperture Signal Lever on the lens is resting at the bottom—the position for smallest aperture. If you operate the Stop-Down Lever on the camera, it will stop down the lens but to *smallest aperture* rather than shooting aperture for the next exposure. Also, if you attempt to perform stopped-down metering with an EF on automatic, you'll get an incorrect reading. In fact, stopped-down metering is never recommended with FD lenses mounted on the EF.

HOW A-SERIES CAMERAS SET EXPOSURE AUTOMATICALLY

The A-1 and AE-1 use the lens in a different way, when set to automatic. Operating the film-advance lever moves the Aperture Signal Coupling Lever in the camera to the top of its travel and it is *latched* in that position. Because the Aperture Signal Coupling Lever in the camera fits underneath the Aperture Signal Lever on the lens, this causes the lens Aperture Signal Lever to move to the top of its travel also, and holds it there. This position corresponds to fully open aperture.

When you depress the shutter button, the camera instantly decides the amount of exposure, using an electronic calculator in the camera. Simultaneously, the Aperture Signal Coupling Lever in the camera is unlatched so it is free to move.

Spring tension *in the lens* causes the lens Aperture Signal Lever to move downward which pushes down the lever in the camera also. The camera monitors the position of these levers and when they are in the right position for the desired aperture size, the camera lever is *clamped* so it can't move any more.

This holds the Aperture Signal Lever in the lens at the desired position. Then the Stopped-Down Coupling Lever in the camera operates the Automatic Aperture Lever on the lens which causes aperture to stop down to the desired value for the exposure.

Before an automatic exposure, the lens Automatic Aperture Lever is held at the top. *After* an automatic exposure, the lever is clamped at the position corresponding to shooting aperture at the last exposure. When you advance film for the next exposure, the levers are again moved to the top and latched there.

There are some special procedures and precautions to observe when using the FD lenses with A-series cameras. These are mentioned but not fully explained in Chapter 18. The explanation is in the working relationship between camera and lens.

Using Other Lenses—It's important to understand that this information about the levers and pins applies only to FD-type lenses because they are the only lenses with all of the levers and pins. Any consideration of automatic camera operation must apply only to FD lenses because they are the only lenses that can be used automatically. Also, they are the only lenses that are meter-coupled to allow full-aperture metering.

The earlier FL lens design has only the automatic-aperture lever and must be used with stopped-down metering.

As you will see in the next chapter, one way to get higher magnification of the image is to install accessories between the lens and the camera body. Some of these accessories preserve the mechanical linkages between lens and camera so an FD lens can be used with full-aperture metering or automatic operation even with the accessory installed.

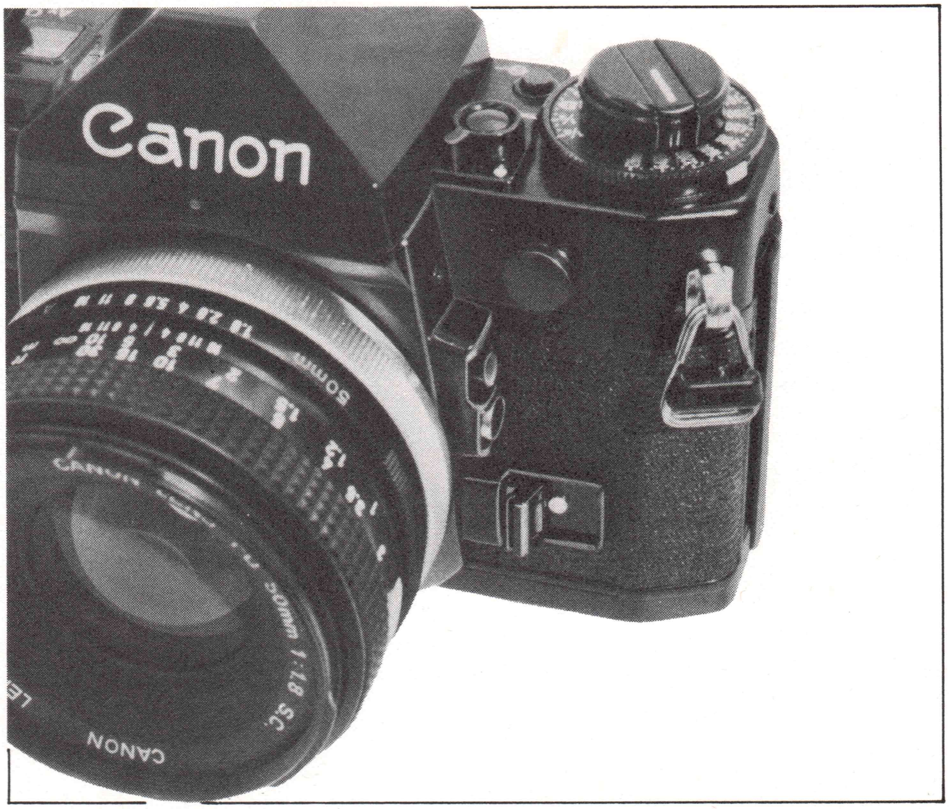
Some of the accessories that fit between lens and camera *do not* preserve the mechanical linkages between lens and camera. When using these accessories, you must use stopped-down metering even with an FD lens.

Canon SLRs have a procedure for stopped-down metering. Generally, it's just to push in the Stop-Down Lever but there are some additional procedures with A-series cameras. Chapter 18 includes stopped-down metering instructions for each model.

If an A-series camera is set to work automatically with an FD lens by turning the lens aperture-control ring to A, the Stop-Down Lever is blocked so it cannot be operated. The reason is: Stopping down the lens would require unlatching the Aperture Signal Coupling Lever in the camera. If this were done, the next frame could not be exposed automatically because the exposure sequence must begin with the lever latched at the top.

If you attempt stopped-down metering or viewing after an automatic exposure has been made, but *before* advancing film for the next frame, the lens cannot stop down smaller than the shooting aperture for the preceding frame—because the levers remain clamped until you advance the film.

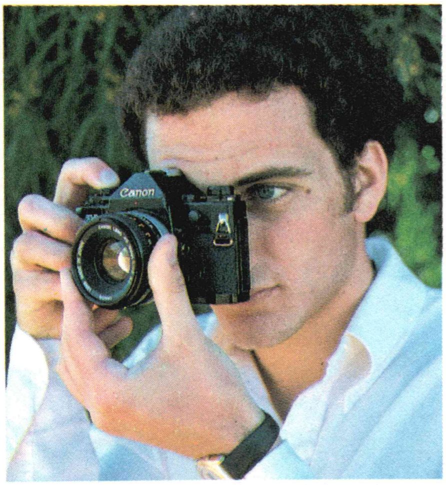
By switching to manual aperture control, you can operate the Stop-Down Lever. If film has already been advanced, you will see correct depth of field. However the Aperture Signal Coupling Lever in the camera becomes unlatched. To reset the camera for automatic operation requires special procedures described in Chapter 18. The procedure is different for the A-1 than for the AE-1.

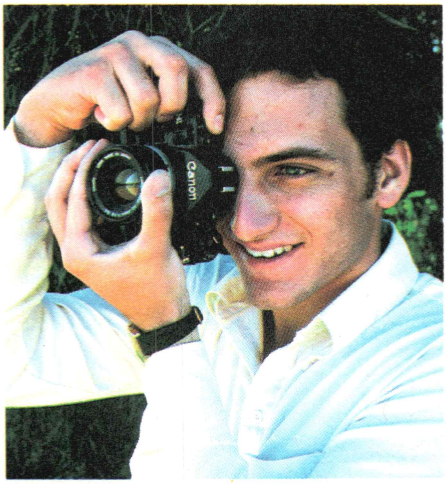


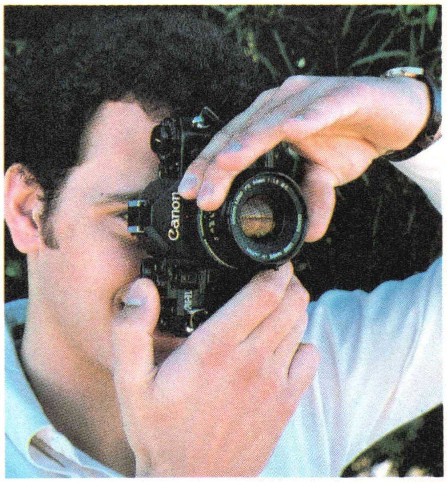
The Stop-Down lever on the A-1 is easy to use. The outer end folds out as shown to act as a handle. Push inward on the handle to stop down the lens. The small chromed button pops out to hold the lever in. To release, fold down the handle. This automatically pushes in the chromed lock button which allows the lever to return to its normal position.

11

VIEWING AND FOCUSING

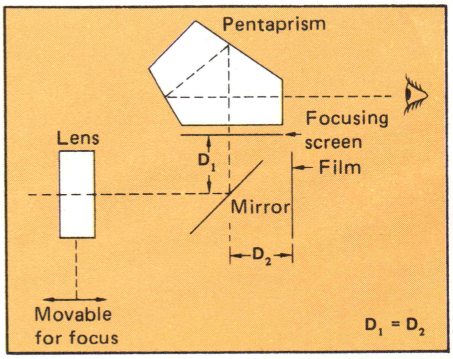

When hand-holding the camera, take a relaxed, stable position. Grip the camera firmly, pressing it against your cheek and forehead. Stop breathing while you smoothly squeeze the shutter button.


To hold the camera vertically, most photographers put the shutter button at the top. Left-eyed people encounter nose interference and may need the thickness of a thumb between camera and forehead. It's a good idea to support the lens with your left hand.


Some photographers prefer to make a vertical shot this way, using the thumb to operate the shutter button. However you do it, learn to minimize camera motion during exposure.

In an SLR camera, one purpose of viewing the image from the lens is to determine if it is in good focus. The way to do this is put a ground-glass viewing screen above the mirror with the mirror angled so it intercepts light rays from the lens. The irregular surface of the ground-glass screen is called a *matte* surface. Each small point on the screen receives light from the lens and becomes luminous. Each small point retransmits light rays toward the eye of the camera operator. What you see is the image on the screen whether it is in focus or not.

The camera is designed so the distance from the lens-mounting surface to the film plane is the same as the distance to the viewing screen by way of the mirror. Therefore if the image is in focus on the viewing screen it should also be in focus on the film when the mirror is moved out of the way. When you make focus adjustments you are using the viewing screen as a substitute for the surface of the film.



Distance from lens to focusing screen by way of mirror must be identical to distance from lens to film when mirror is raised. Judging focus by looking at the screen is equivalent to examining the image on the film.

VIEWING SCREEN BRIGHTNESS

A matte screen works fine as a way of locating a plane on which to judge image focus. It tends to be brighter in the center than the edges unless the brightness is corrected by another lens.

As shown in Figure 11-1, each point of the matte screen, when acting as a light source, sends light rays forward in all possible directions. Away from the center of the screen, the rays are not directed toward the observer's eye, so the screen appears dark around the edges.

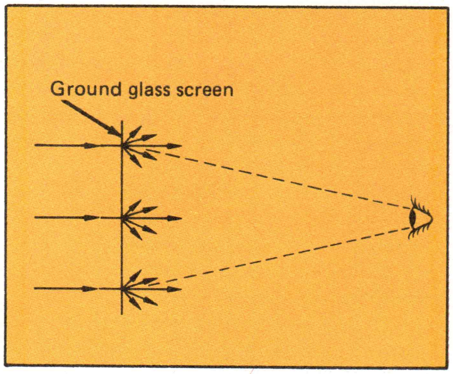


Figure 11-1/Most focusing screens use an irregular *matte* surface such as ground glass.Without correction for the edges, much of the light goes out of the observer's line of vision. An uncorrected ground-glass screen appears dark around the edges even when the image itself is uniformly bright.

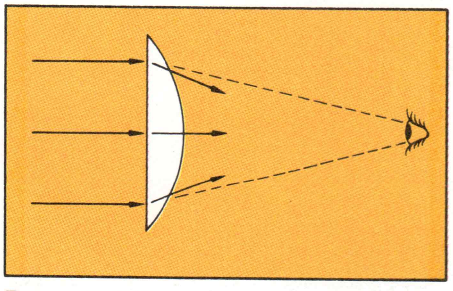


Figure 11-2/Correction of uneven illumination of a viewing screen is made by a *field lens* which bends the outside light rays toward the viewer's eye.

More uniform viewing-screen brightness is obtained by use of a converging *field lens* which bends the rays from the edges of the screen toward center, as shown in Figure 11-2.

A field lens to correct screen brightness tends to be thick and heavy. The part of a lens which refracts light rays is the front and back surface—the glass inside does nothing. Therefore it is possible, for special applications, to remove glass from the inside of the lens without changing the contour or shape of the surface. Visualize the result, a *Fresnel lens,* by looking at Figure 11-3. The lens is divided into a series of concentric rings by slices through the lens.

Each concentric ring can be made thinner by removing material from the inside without changing the shape of either top or bottom surface. Vertical faces between the circular segments of the lens appear as circular lines in the image. For viewfinding, the circles due to a Fresnel lens are not objectionable.

Sometimes more than one converging lens is used to perform the ray-bending needed to correct viewing screen brightness. Canon uses a Fresnel lens below the viewing screen and a non-Fresnel converging *(condenser)* lens above the viewing screen. Some models have an inclined semi-reflecting plane inside the top condenser lens to capture some of the light passing through the lens and reflect it to the light sensor for exposure metering.

FOCUSING AIDS

Judging focus by looking at the image on a matte screen depends a lot on how good your eyesight is. Even with good vision it is inferior to other methods of indicating good focus. Two other methods, called *focusing aids* are used.

A split-image focusing aid is two small prisms with their faces angled in opposite directions as shown in Figure 11-4. This focusing aid has the outer edges of the prisms trimmed to form a circle.

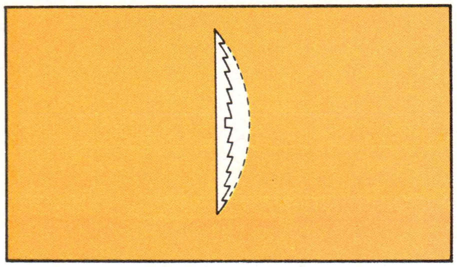


Figure 11-3/To save weight and space, a converging lens can be "flattened." Viewed from the front, this lens shows concentric circles at the steps in the lens contour. This is a Fresnel lens.

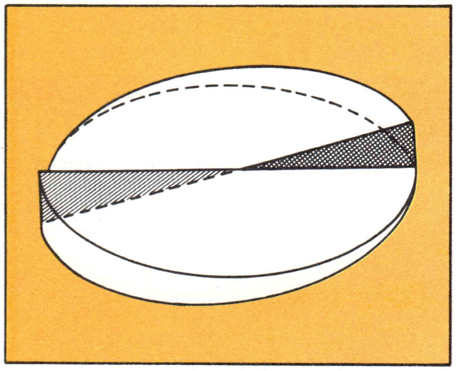


Figure 11-4/A biprism is two wedges of glass, tapering in opposite directions. Normally made to fit a circular area in the center of the viewing screen.

Each of the two prism faces refracts or bends light rays which pass through it. If the image from the lens is brought to focus *in front of the viewing screen,* rather than *at* the viewing screen, the two halves of the image appear misaligned as shown in Figure 11-5, page 55.

If the image comes to focus *on the viewer's side of the screen,* the effect is reversed and the image is misaligned in the opposite direction. At the point of best focus, the two halves of the image are not displaced in respect to each other.

The human eye is better at judging alignment of lines or edges in an image than judging focus by general appearance so a split-image focusing aid is a good way to find focus.

For most effectiveness with vertical lines in the scene, the display should move the top half of a vertical line to the right or left and the

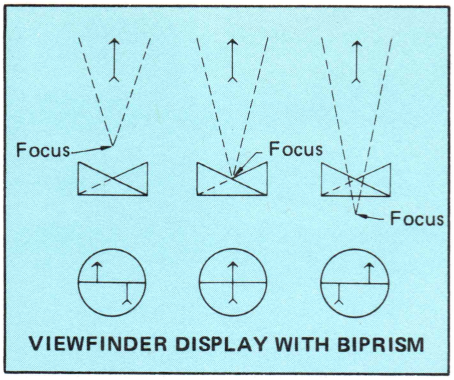


Figure 11-5/A biprism visually separates lines into two displaced segments when the image is not in focus.

bottom half in the opposite direction.

If the prisms are positioned in the camera to split vertical lines and the image consists mainly of horizontal lines, it will be difficult to see any indication of focus. The *biprism* could be rotated 90 degrees and then it would split horizontal lines so one half moves up and the other half moves down. But this wouldn't work well on vertical lines. If you need 90 degrees for precise focusing, just angle the camera.

Some split-image viewfinders are angled at 45 degrees to give some focus indication on both vertical and horizontal lines.

Imagine that your eye is looking out at the scene through the biprism and the lens. Your line of sight will be displaced in one direction by one prism and in the other direction by the other prism. If the angles of the prism faces are too large, your line of sight can be changed so much that you end up looking at the side of the lens tube instead of out through the lens.

Even though the prism angles are small enough to allow you to look through the lens at full aperture, a smaller aperture may block your line of sight so you end up looking at the back side of the aperture diaphragm rather than out to the world beyond. This is common with focusing aids of this type and the biprism will seem to go black on one side or the other.

The side that goes black depends on where your eye is. Move your head one way or the other and the opposite side of the biprism will go black. By changing the position of your eye, you alter your line of vision to favor one prism or the other.

This problem puts the camera designer into a technical conflict. Large prism angles cause large image displacements when the image is not in focus and therefore give a very good indication of focus. However, the larger the angle the sooner the focusing aid blacks out when stopping down the lens. The problem is worse with slow lenses.

Standard lenses start to black out the prism-type focusing aid at about *f*-4. At *f*-5.6 and smaller apertures, the focusing aid does not work.

This is not a handicap when focusing at full aperture, but you will notice the effect when you stop down to judge depth of field or if you attempt to use the focusing aid when stopped down below the critical aperture size.

A biprism which splits lines doesn't work well when there aren't any lines in the picture. The worst case is either a plain surface or a mottled surface such as a mass of foliage.

Another type of focusing aid which is more useful on scenes without strong geometric lines is a *microprism,* shown in Figure 11-6.

It is an array of many small pyramids whose intersections work in a way similar to the biprism. Visually, the microprism displaces small segments of the image causing it to "break up" and have an overall fuzzy appearance. When focus is reached, the image seems to "snap" into focus.

A microprism is even more helpful when hand-holding the camera. You can jiggle the camera—on purpose or because you can't help it—and the image will seem to scintillate when it is out of focus.

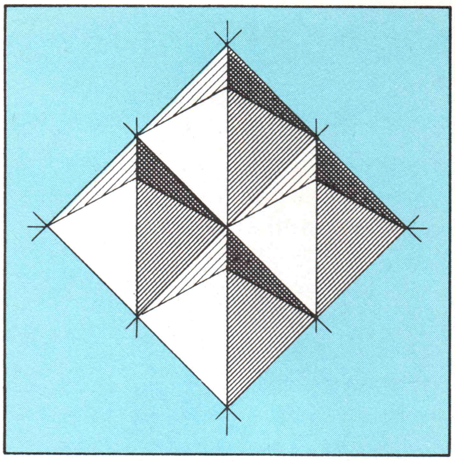
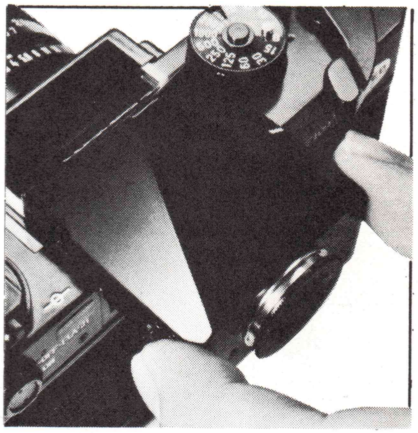


Figure 11-6/A microprism is an array of small pyramids whose intersections work like little biprisms. Microprisms work well on any subject with surface details.

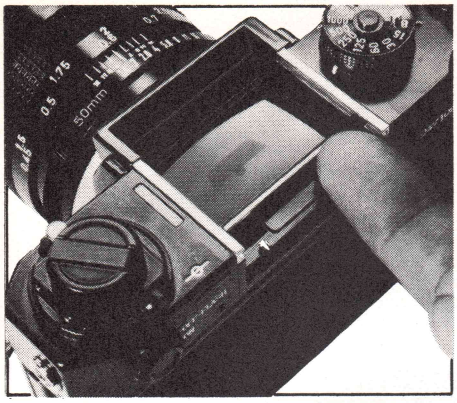


To remove the pentaprism of an F-1 camera, squeeze the two knurled buttons on each side and pull the pentaprism straight back.

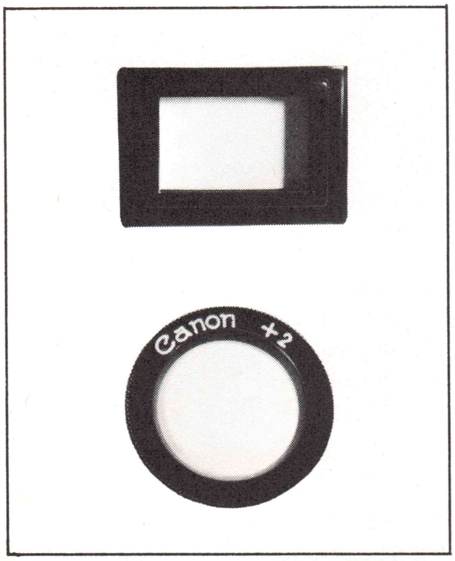
Because operation of the microprism is similar to the biprism, it has the same problem with blackout at reduced apertures. Blackout at around *f*-5.6 is also usual with microprisms.

The Canon F-1 has a removable pentaprism to allow use of interchangeable focusing screens and you can choose from 9 different types which include split-image, microprism and others, illustrated on page 146.

Among those nine interchangeable focusing screens, two have different microprism angles than standard. One for large-aperture



To exchange viewing screen of an F-1, remove the pentaprism. Lift up the rear edge of the screen until it clears the back of the camera, then slide it out. If the bottom of the screen scrapes on the camera back, the screen will be permanently scratched. To install a screen, reverse the procedure, again being careful not to scratch the bottom surface.



Some Canon cameras have rectangular viewing windows, some round. Dioptric Adjustment Lenses are made to fit either shape, identified as S and R for square and round. To put your eyeglass prescription into the viewing optics so you can shoot without wearing your glasses, order the Dioptric Adjustment Lens nearest to your distant-vision eye correction. For example if your eye correction is +1.5 diopters and your camera has a square (rectangular) viewing window, order S +1.5.

lenses has steeper faces on the microprisms. The other for small-aperture lenses and long telephoto lenses has smaller microprism face angles so the display does not black out as early when stopping down.

Combined Focusing Aids—Some cameras, including the A series, include both focusing aids in a single screen. A split-image biprism surrounded by a microprism gives you a choice without having to exchange viewing screens.

VIEWING AIDS

Accessories are available which attach to the viewing eyepiece of all camera models. Dioptric Adjustment Lenses allow you to put your eyeglass prescription into the viewing lens.

A rubber eyecup excludes stray light while you are looking into the viewfinder. It makes viewing more comfortable for some people and prevents reflections from the glass surface of the viewfinder window which can be distracting and prevent a good view of the screen.

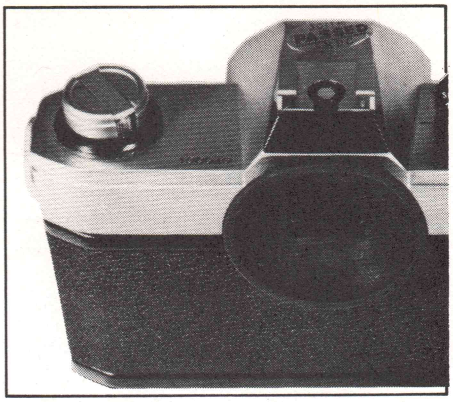
The normal viewing arrangement through the window on the back of the camera is called eye-level viewing and is convenient for most shooting. If you have the camera at ground level, it is inconvenient to get your eye where it needs to be to look through the finder window.

Two Angle Finders, B and A2, mount on the viewing window and can be positioned so you view from the top of the camera. The angle finders can also be rotated to allow other ways to view. They have their own adjustments to fit your eyesight.

Angle Finder B gives a correct image, left to right and top to bottom, meaning there is no reversal of the image. Angle Finder A2 is a simplified type which reverses the image from left to right, but not vertically.

For critical focusing, a Magnifier can be attached to the viewfinder. Magnifying the image on the viewing screen helps focus accurately but you can't see the entire screen. For composing move the magnifier up out of the way.

For the F-1 only, a Waist-Level Finder can replace the pentaprism. It allows you to hold the camera at your waist and view by looking down at the top of the camera. Its built-in flip-up 5-power magnifier permits critical focusing. This finder reverses the image from left to right when the camera is held normally and also obscures the exposure display, so metering and exposure settings must be made before exchanging the pentaprism



Rubber eyecups are comfortable and exclude stray light which can make viewing difficult and may influence the exposure meter reading by coming into the "back door" of the camera. They are made to fit square and round viewing windows.

Canon MAGNIFIER

Magnifier attaches to viewing window and magnifies part of the focusing screen so you can judge precise focus. It also flips up for normal viewing. Useful for copying and high-magnification photography.

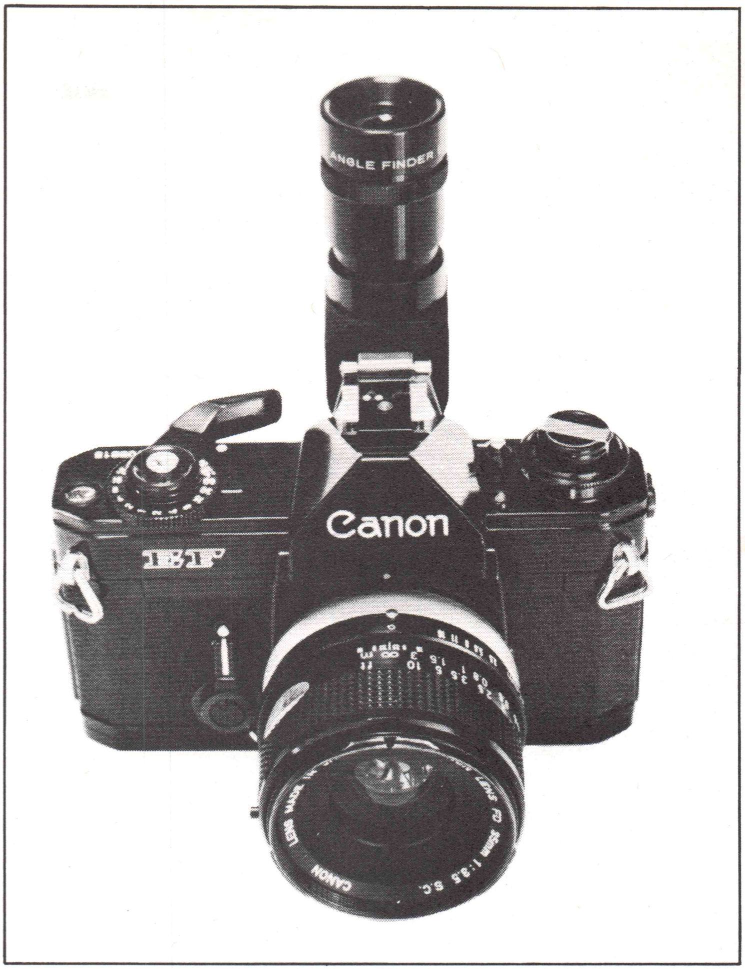
for the Waist-Level Finder.

A more convenient special finder for the F-1 is the Speed Finder. It also replaces the pentaprism and presents a correct view of the image while displaying metering information. It can be viewed with your eye at a distance from the viewing window without losing sight of part of the frame. Your eye can be as far as 60mm (approximately 2 1/3 inches) from the window, handy for eyeglass wearers and action photographers.

The Speed Finder can be rotated to allow eye- or waist-level viewing. In a crowd, you can hold the camera over your head and view through the Speed Finder as you would for waist-level viewing. Although you will not be able to see the entire frame you can still see enough to point the camera.

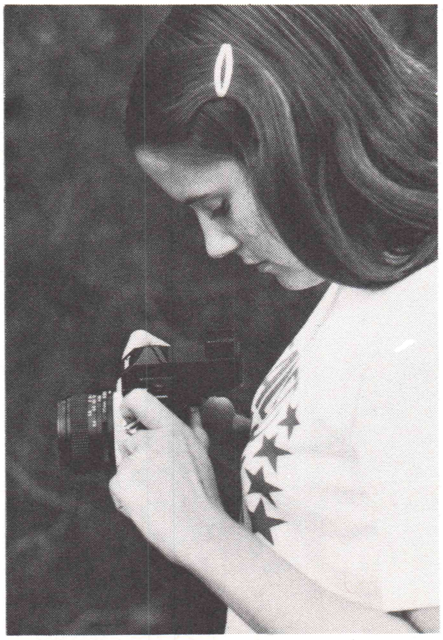
If you use the F-1 camera, seriously consider the unique Canon Speed Finder. Try the accessory mounted on a camera at your dealer's shop to see how it aids viewing with the camera held anywhere—including flat on the floor.

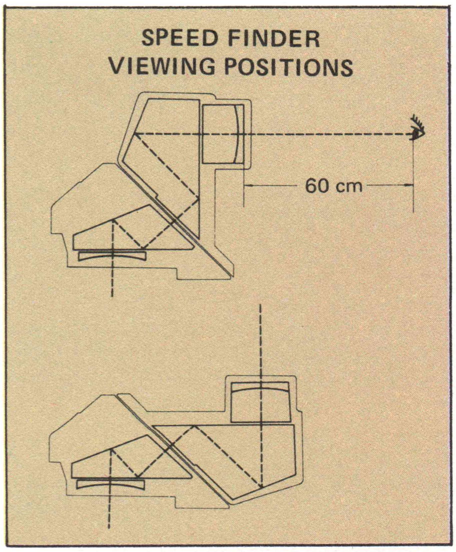
The F-1 also uses the Servo EE Finder and the Booster T Finder. Because they are more than just viewing aids I've discussed them in the following chapter.



Angle Finder B snaps in place and allows viewing from the top. It pivots forward, out of the way, for normal eye-level viewing.

Speedfinder shows full view without your eye being close—handy for eyeglass wearers. It swivels to allow eye-level, waist-level or overhead viewing.





Speedfinder gives a correctly-oriented view of the scene no matter which way it's swiveled.

12

EXPOSURE METERING

The purpose of Through-The-Lens metering is to get correct exposure onto the film. Measuring the light after it has gone through the lens and any accessories such as filters is an advantage because what the internal light meter "sees" is the light that will expose the film.

Canon uses two types of light sensors: Cadmium-sulfide which has been virtually standard in recent years, and silicon which is more sensitive and requires more electronics in the camera.

Light measurement alone is not enough. Some sort of exposure calculation must also take into account the amount of exposure the film needs *and* the length of time the shutter will be open.

The output of the light-measuring sensor in the camera—cadmium-sulfide or silicon—is fed into a calculator along with ASA film speed and the shutter speed. Except for automatic operation, such as the A-1 and AE-1, you have manual control of the variables and should normally adjust *f*-stop and shutter speed so the display indicates proper exposure.

The light sensor depends on optics in the camera to send an amount of light to the sensor which is a valid sample of the light which will expose the film. This is not a simple thing to do.

A basic design feature which makes an SLR different from other cameras is: *The image reflected onto the viewing screen is the same as the image that will later fall on the film.* The viewing screen can be used as a substitute location for measuring light just as it is a substitute location for judging focus and composition of the picture.

It would be convenient to place the sensor on the viewing screen itself, except it is not transparent and would block that part of the picture from your view. An alternate approach is to locate the sensor elsewhere but allow it to view the screen and measure the light on all or part of the frame area.

Canon uses two sensor locations depending on the model: behind the pentaprism *or* adjacent to the condenser lens at the top of the viewing screen. The latter method will be discussed first.

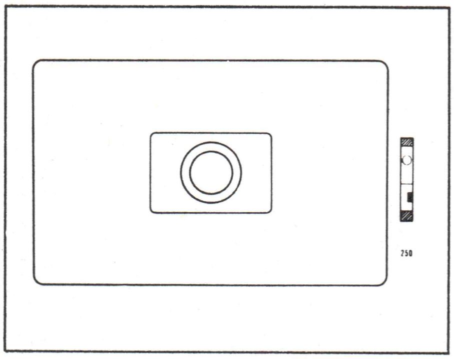
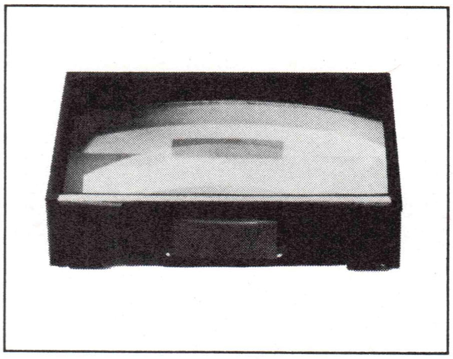


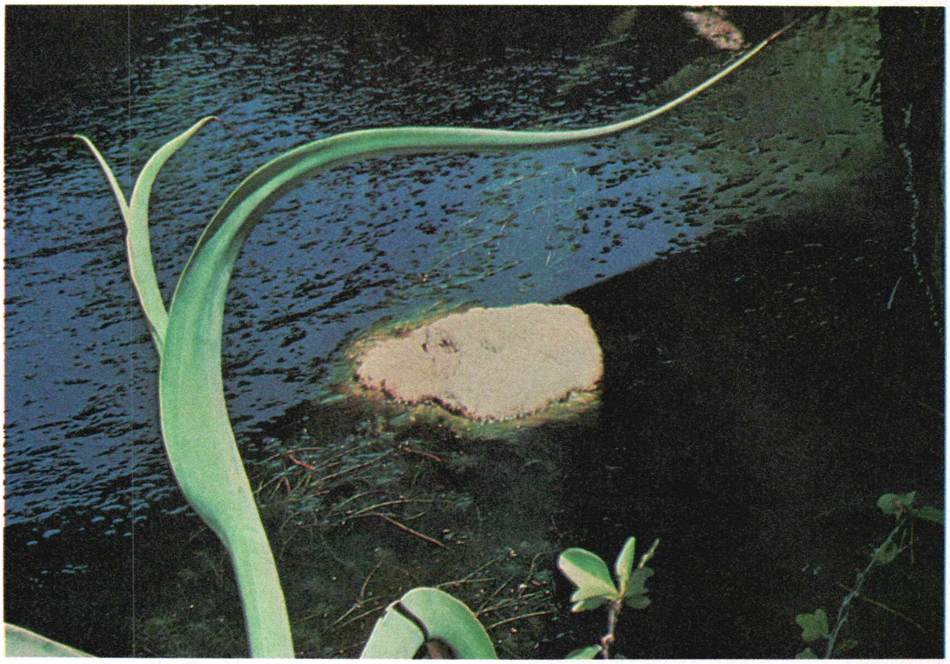
Figure 12-1/The viewfinder displays of F-1 and FTb cameras are similar. Center circle is the focusing aid—a microprism in the FTb and whatever you select for the F-1, depending on the viewing screen in use. The narrow ring around the focusing aid is a plain ground glass surface. Beyond that is a series of faintly visible concentric circles due to the Fresnel lens below the focusing screen. These circles are not shown on the drawing. The rectangle in the center is the metering area, normally a little darker than the rest of the frame.

Figure 12-1 shows the viewfinder display of F-1 cameras. The FTb is similar. The center circle is a focusing aid. The narrow ring around it is a matte surface and concentric Fresnel rings start at the outside of the matte ring.

The rectangle surrounding the microprism area shows where the sensor takes the light measurement. The rectangular metering area occupies about 12% of the total picture area. Because some of the light is actually removed from that part of the viewing system, the image is darker within the rectangle than outside of it.



F-1 and FTb focusing screen assembly is a sandwich with viewing screen at bottom, Fresnel lens in the middle and condenser lens on top. Rectangular semi-reflecting surface inside the condenser lens is visible. Window at back of assembly transmits light from semi-reflecting surface to the light sensor located just behind window. Screens are interchangeable on F-1 but not on FTb.



By control of exposure, you control the brightness of each part of the scene as it appears in the photograph. In a way, it's like painting with light.

It is very important to understand that this is the *only part* of the picture area where light measurement is made. This greatly affects the technique of using this metering system.

Let's compare this type of metering, used in the F-1 and FTb, with two other ways of measuring light from the scene.

Some cameras and most hand-held accessory light meters used separate from the camera are designed to measure light from the entire field of view. A bright spot in the corner of the scene will have just as much effect on the meter as a bright spot in the middle. This is called *full-field* metering.

A special type of hand-held accessory light meter has a very narrow measuring angle such as one degree and therefore accepts light from a small spot on the scene. They are called *spot meters.*

The built-in meter in the FTb and F-1 is between full-field and spot metering, so it's called *semi-spot* metering.

The way the Canon semi-spot meter takes light from the camera viewing screen is shown in Figure 12-2.

The light reflected by the angled semi-reflector in the condenser lens emerges at the back of the condenser to fall directly on the light sensor unit. There it is converted into a variation in electrical current which operates the meter needle.

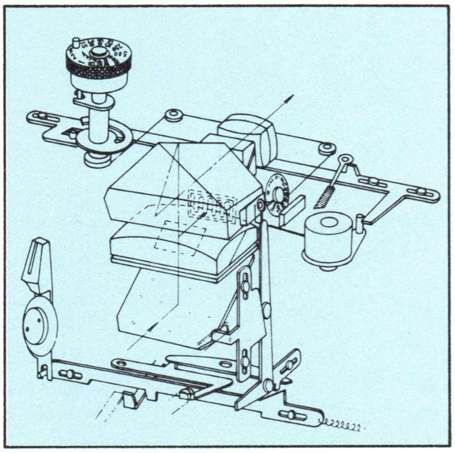


Figure 12-2/Light bounced off the mirror of the F-1 or FTb travels upward through the viewing screen assembly, through the pentaprism and out the viewing window. The dotted-line rectangle in the condenser lens above the viewing screen is an inclined semi-reflecting surface which reflects part of the light toward the back of the camera and onto the light-measuring sensor.

CENTRAL-EMPHASIS METERING

Another light-sensor position is shown in Figure 12-3. The light sensor, or *photocell,* "looks" into the back of the pentaprism from a position adjacent to the viewing window. It sees the entire focusing screen surface and responds to the light from the screen. The area of the screen which affects the light sensor is not held within a closely defined area as in the semi-spot system.

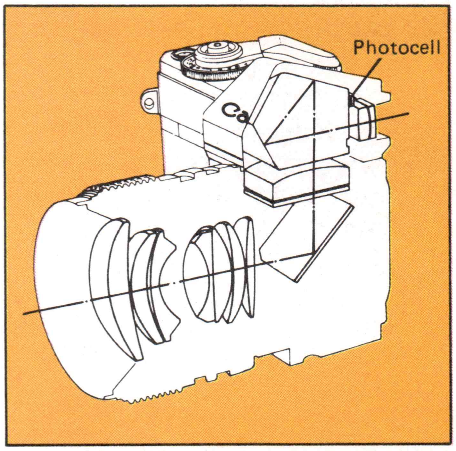


Figure 12-3/Canon cameras *without* semi-spot metering measure light another way. Condenser lens above viewing screen does not have semi-reflecting surface. Photocell above viewing window at back of camera "looks at" viewing screen.

In most shooting situations, the subject of interest is near the center of the frame and more importance should be given to light from that part of the scene. The Canon light sensors located behind the pentaprism respond more to the central area of the screen than to

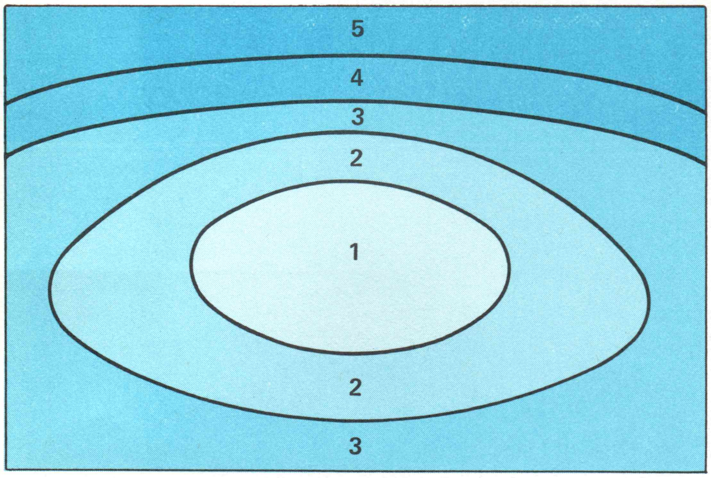
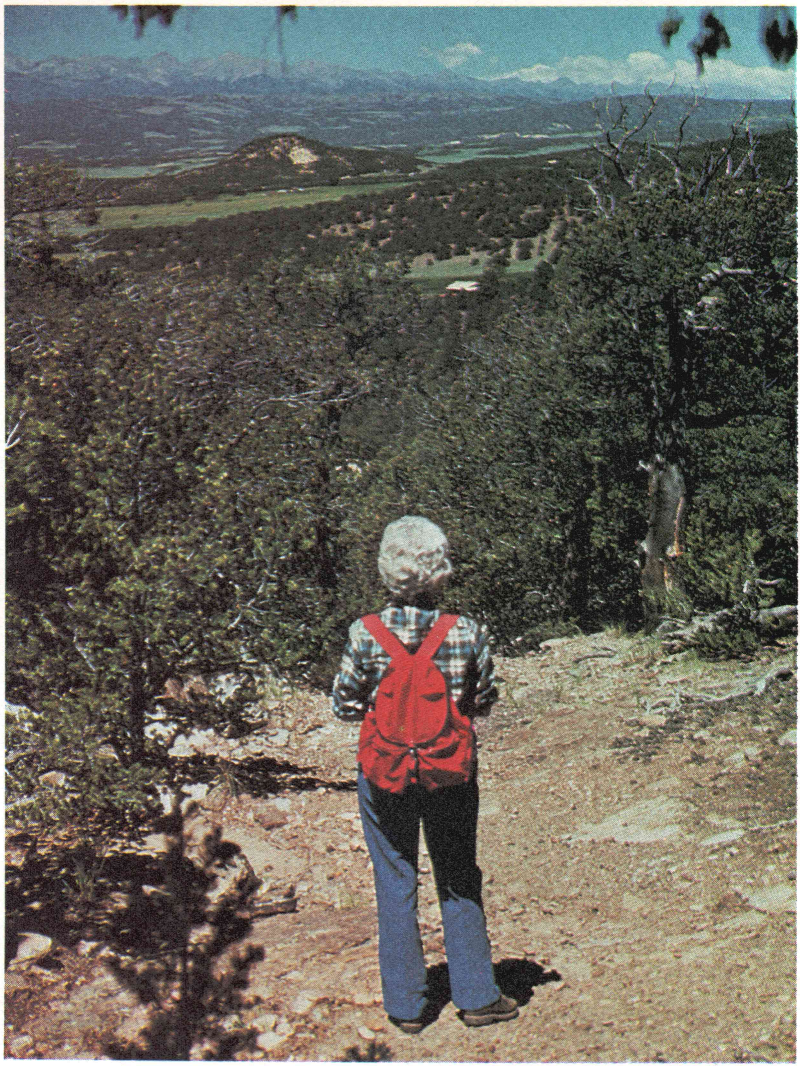


Figure 12-4/Meter sensitivity pattern of the EF shows *most* sensitivity in zone 1, *least* in zone 5 which is often bright sky background. Canon calls this Central Emphasis Metering.



Average outdoor scenes include some sky, foliage, dirt and people but not portraits. All average scenes reflect 18% of the light averaged over the entire frame, whether photographed in color or b&w.

the edges. The sensor has minimum response to light at the top of the screen because this is often bright sky which can cause underexposure of the subject of interest.

Canon calls this Central Emphasis Metering. As shown in Figure 12-4, the center zone represents maximum sensitivity of the light-measuring system and each defined area outside of the central part has less sensitivity. Five different regions of sensitivity are shown, with least-sensitive regions 4 and 5 at the top of the frame where there is often only sky.

Central Emphasis Metering allows shooting with less attention or thought to backgrounds.

Central Emphasis Metering is used in the TX, TLb, EF and all A-series cameras on both non-auto and automatic operation. The user of a camera which sets exposures automatically is entitled to use the automatic feature and expect it to give successful exposures most of the time. The Central Emphasis metering system does just that and does it without any active thought or cooperation from the operator.

Automatic cameras are likely to be used in situations where fast shooting is needed which is another reason to use a metering system which allows the operator to point and shoot.

AN AVERAGE SCENE

In the discussion of over- and underexposure, I pointed out that film has a limited range of density between fully clear and fully black. An important idea of exposure is to cause the various light values from a scene to produce densities within the range of the film. The safest thing to do is put the middle light value of the scene right on the middle density of the film density scale. Then higher and lower light values from the scene "have a place to go" on the film.

By measurement of many typical scenes, it has been found that most outdoor scenes and many shots in a man-made environment have the same average amount of light coming from the entire scene. Some parts are brighter and some are darker but they average out, or *integrate,* to the amount of light that would come from a certain shade of gray. This gray shade is called 18% gray because it reflects 18% of the light that falls on it.

I think we are indebted to Eastman Kodak for this discovery. Anyway, Kodak publishes cards which are 18% gray on one side and 90% white on the other. These cards are bound into some Kodak reference books, and sold separately at camera shops.

The inside covers of HPBooks' *SLR Photographers Handbook* are approximately 18% gray so you can use them as a metering aid. The idea is that you can meter on a average scene, or meter on an 18% gray card in the same light, and the exposure meter in your camera will give the same settings.

The percent of incident light reflected by a surface is called the *reflectance* of that surface. Average scenes have 18% reflectance overall, and the middle tone of an average scene has 18% reflectance and looks the same as the gray card—at least to the camera light meter.

The middle density of the range of densities which film can produce corresponds to that same 18% gray. Which says, again, that the middle tone of a typical scene should record as the middle tone on the film. You cause that to happen by adjusting the exposure controls on your camera.

The value 18% may not seem like the middle or average of anything, but remember we are considering human vision.

Black velvet reflects about 3.5%—about as black as you will find except for a hole where light goes in and nothing comes out. White paper is about 90%.

There sits 18%, smugly in the middle between black velvet and white paper: *The middle tone,* as seen by our eyes.

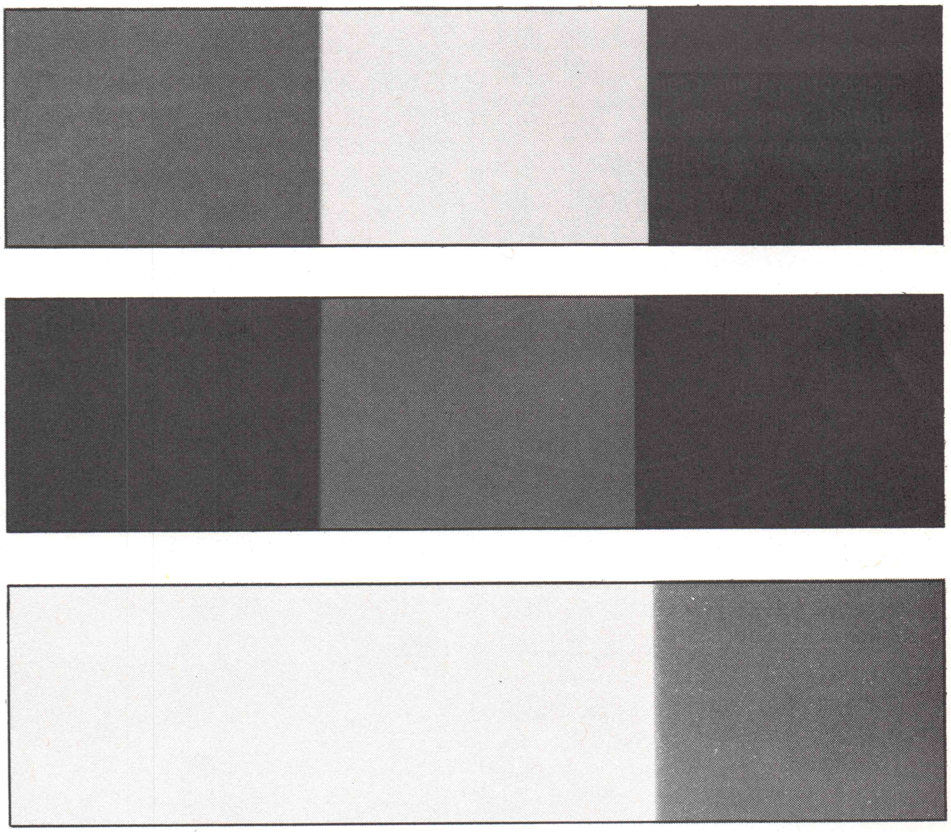
There are about 5 exposure steps between black and white when the scene is uniformly illuminated, so 18% gray is about 2.5 steps above black and 2.5 steps below white.

HOW TO INTERPRET EXPOSURE READINGS

If you decide to go around photographing 18% gray cards, I guarantee every exposure will be a whopping success. It's built into the system. The exposure called for by ASA film-speed ratings will put an 18% gray card right in the middle of the density scale of the film. Camera makers build cameras so they will give the amount of exposure called for by the film-speed number if you match the needles or if you allow an automatic camera to do its thing.

It takes good photographic judgment to look at a real-world scene and decide if it will average out to 18% gray. If so, you can shoot it just as you would a gray card—follow the advice of the camera exposure meter. Most outdoor scenes have sky, people, dirt, rocks, foliage and maybe a distant building. This is average. If your scene is mainly sky, that is not an average scene *but the exposure meter in your camera doesn't know the difference.*

The exposure meter, unless you override it with your own good judgement, will place the *average* brightness or tone of every scene at the middle density of the film. If the scene is mainly sky, sky will be rendered middle gray on the



This exciting panorama shows the importance of metering. In real life, this was medium gray on the left, white in the center, black at right. In the top photo, meter reading was taken from the gray surface. All three tones reproduced properly. In the middle, metering was done on the white surface. White became gray, gray became black, black couldn't get any blacker. At bottom, metering was done on the black surface which became middle gray on the negative. Gray became white and white couldn't get any whiter. Depending on how you meter, you can shift all tones toward white or toward black.

print and faces of people against the sky will be too dark.

Here's a way to waste two frames of film in the interest of science: Photograph a piece of white paper on one frame of film and a piece of black paper on the next frame. Use either b&w or color-slide film. Adjust the camera controls to satisfy the exposure display each time. After development, examine the b&w negative or the slide. The two frames should be the same shade of gray—18%.

You can only believe your exposure meter when it is looking at an average scene. If you shoot a bird on a snow bank, the camera will think the snow bank is a gray card in very bright light. It will stop down so the white snow appears gray on the negative. If faithfully printed, it will also appear gray on the print.

If you shoot a coin on black velvet, the camera will think the gray card is in very poor light and open up the lens until the black velvet registers middle gray on the film.

The clue is the amount and brightness of the background. If the subject is small and the background large, worry. If the background is significantly brighter than middle gray, you know the camera will want to stop down on account of the bright background and underexpose your subject. You have to give more exposure than the exposure meter will suggest.

If the background is significantly darker than average and your main interest is the subject against that background, you have to give less exposure than the meter suggests to avoid overexposing the subject.

Another situation where an exposure meter may give an unsatisfactory reading is when everything in the scene is unusually light or dark. If you photograph a marshmallow on a white table cloth, the exposure meter will suggest camera settings which make everything middle gray on the negative. If printed that way, the result is a gray marshmallow on a gray table cloth—probably not your intention.

To make marshmallow and cloth both appear white on the negative, you probably need about two more steps of exposure than the meter will suggest.

Similarly a dark subject against a dark background will both be changed to a medium gray by the unthinking exposure meter if you allow it to happen. For realism, you probably want both subject and background to appear dark on the print. You probably need one or two steps less than the meter will suggest.

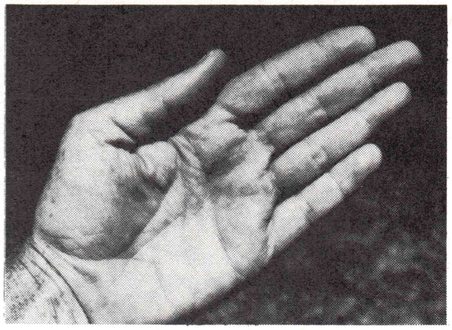
With an automatic camera, the exposure-measuring system does more than suggest exposures. It adjusts the camera and takes the picture the way it thinks is right. I'll tell you in a minute how to prevent an automatic camera from making an incorrect exposure of a non-average scene.

SUBSTITUTE METERING

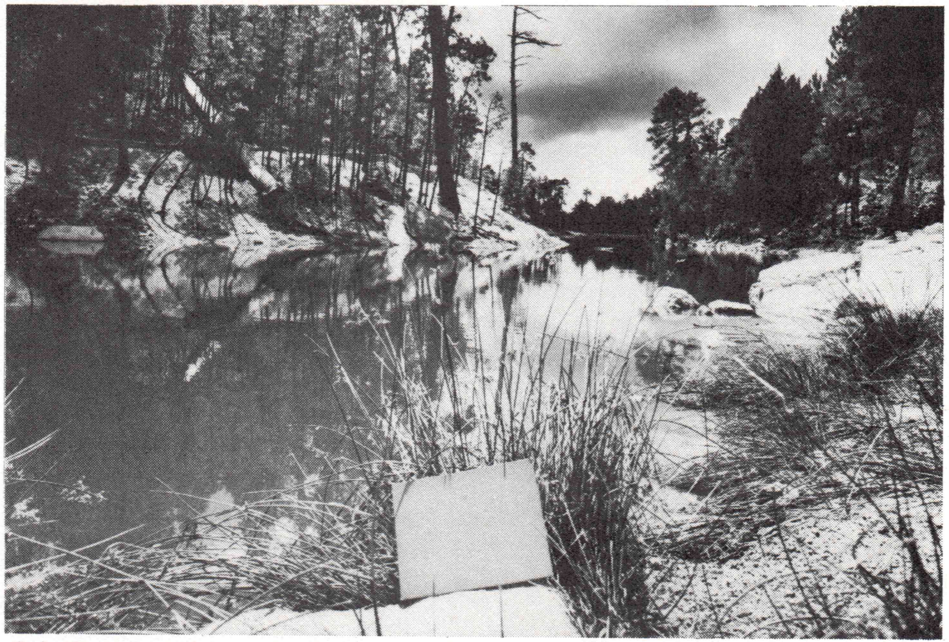
This is a way to solve some difficult exposure problems. Suppose you are shooting a scene with no middle tone. Everything is very bright or very dark. If areas of bright and dark are about equal and the exposure meter includes an equal amount of each, the meter itself will average light and dark and give an exposure as though it was examining the middle tone of the scene. For example, a checkerboard with black and white squares will affect a meter as though it was a uniform gray color.

This requires some judgement on your part as to how bright and how dark the two extremes are and whether they appear in equal amounts to the meter.

You can sidestep the problem by



A handy substitute metering surface you are not likely to leave behind is your handsome palm. Most palms reflect about 36% of the light. Meter on your palm in the same light as the scene, open up one stop and shoot.



Substitute metering can be done on an 18% gray card in the same light as the scene. Set the camera exposure controls according to light reflected from the gray card and then shoot the scene. Of course it doesn't matter if you remove the card when taking the picture. Tones in the scene will be recorded correctly on film—color or b&w.

placing an 18% gray card in the scene, so it receives the same amount of light as the rest of the scene. Meter on the card and shoot at the exposure setting which results. The picture will show the 18% gray card as a middle tone with the bright and dark areas appropriately lighter and darker than middle gray.

If you remove the 18% gray card after taking the reading but before exposing the film, the picture will be the same as before except the card won't be there. Bright and dark areas will reproduce properly.

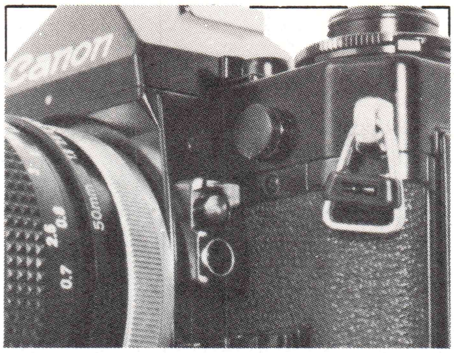
If it is not convenient to place the 18% gray card at the scene—perhaps because the scene is on the other side of a chasm or river—you can meter on the card anywhere as long as it is in the same light as the scene. If you are shooting in sunlight for example, you can assume it has the same brightness everywhere as long as it falls on the scene or subject at the same angle. Hold the gray card near the camera in the same light as the scene and meter on the gray card.

Metering on a substitute surface instead of the scene itself is called *substitute metering.* Many photographers carry an 18% gray card for this purpose.

In dim light, a gray card may not reflect enough light to allow metering. Some gray cards are 90% white on the reverse side and white paper is about the same. If you meter on 90% white instead of 18% gray, the white card will reflect *five times* as much light into the exposure meter as the gray card would, because $90\% \div 18\% = 5$.

Because the exposure meter assumes everything out there is 18% gray, it attributes the high value of light to brighter illumination rather than more reflectance of the surface. Therefore it will recommend an exposure only 1/5 as much as it would if you were actually metering on 18% gray. Because you know that, you compensate by *increasing* exposure by 5 times over the exposure meter reading.

To make the correction, multiply the indicated shutter-opening time by 5 and select the nearest standard number. If the exposure meter says shoot at 1/60 second, you will want to shoot at 5/60 second which reduces to 1/12 second. The nearest standard speed is 1/15 second.



Canon A-1 has two pushbuttons on left side of lens mount. Top button, called Exposure Memory Switch, turns on viewfinder display and locks exposure at whatever *exposure value* the camera light meter is reading at the instant you depress the button.

Lower button with chrome ring around it is the Exposure Preview Switch. Depress this button when you want to see exposure-control settings in the viewfinder readout. The Exposure Preview Switch does the same thing as depressing the shutter button partway to turn on the display but it gives you a choice of doing it with your left hand.

You can also correct by changing aperture. Opening up by 2 stops is an increase of 4 times. Opening up aperture by 2 1/2 stops increases exposure 5.6 times. The click stops or detents between the numbered settings of the aperture ring are half-stops.

A very handy substitute metering surface is the palm of your hand. You should check your own palm but light skin typically reflects about one stop more light than an 18% gray card. If so, you can hold your palm in front of the camera—in the same light as the subject or scene—meter on your palm and then open up one stop. If your palm reflects only a half stop more, obviously that's how much to open before shooting.

You will find that dirt, grass, weeds, foliage and other common things have a suprisingly uniform reflectance. You can learn to use them in a hurry as substitute metering surfaces to set your camera for a quick shot of some unusual scene such as a flying saucer passing by. An advantage of using your exposure meter to measure the reflectance of common objects is that it helps you learn to distinguish non-average scenes from average scenes.

HOLDING EXPOSURE SETTINGS WITH AN AUTOMATIC CAMERA

With an automatic camera, you must be alert for non-average scenes. When you photograph one, use substitute metering while the camera sets the exposure controls automatically for whatever you are using as a substitute metering surface. Then hold the camera settings while you take the picture. **A-1 and EF—A** special control holds or freezes exposure settings. On the EF it is a button, called AE Memory Lock, at the left side of the pentaprism on top of the camera. On the A-1, it's a button on the left side of the lens mount called the Exposure Memory Switch.

Use is best explained by example. Suppose you are photographing a person against a very bright sky background and you don't want it to be a portrait taken from close to the subject. Much of what the exposure meter sees is bright sky background. You know if you shoot that way, the subject's face will be underexposed and the sky tone will be grayer than it should be for realism.

After composing and focusing, point the camera down so it picks up less sky and more dirt or grass. With a little sky and more of natures's own terrain, you are metering on an average scene that will integrate to about 18% reflectance.

Push and hold down the memory button and the camera will hold that setting. Then point the camera at the subject as you originally intended and make the picture. As long as you hold down the memory lock, the exposure will stay as it was just before you locked it.

Another way to solve this problem is to move closer until the subject fills one-third or more of the viewfinder area—including the center part where the meter is more sensitive anyway. Because of Central Emphasis, metering is mainly influenced by what you put in the central part of the viewfinder provided it occupies a significant part of the total viewfinder area. Lock the reading, back up to where you wanted to stand in the first place, and take the picture.

You can also use any substitute metering surface in the same light. A gray card is perfect. Your palm is within one stop of perfect and will result in some underexposure if you meter on it. Try it first, before deciding on theoretical grounds. With b&w film and color-negative film, you probably can't find a lot of difference. With color-slide film, metering should be precise and a gray card will serve better than your palm.

Once you begin to think about substitute metering and use your camera to learn the reflectances of common things, you will turn to the technique automatically and often. Not just with automatic cameras because the viewfinder display in a non-automatic will mislead you just as blatantly.

Another way you can take charge on an automatic camera is set it to non-automatic. Observe the exposure settings it wants to use by reading them in the viewfinder display. Then move the aperture ring away from the green mark and set aperture anywhere you want it.

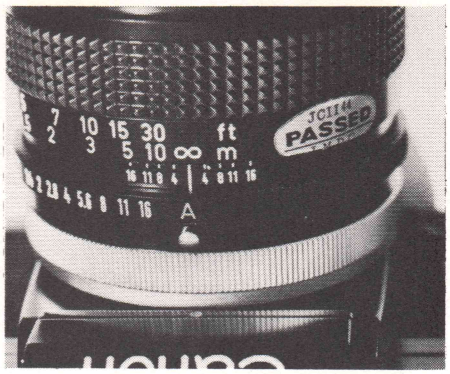
Using The AE-1 Camera—With an AE-1 you can easily perform substitute metering, but there are special techniques to hold the reading while you point the camera to your subject. There is no button for memory hold.

A simple way is to meter on the substitute surface and, while metering, start the self-timer mechanism. In the AE-1, this holds in memory the exposure reading made at the instant you started the self-timer. Be sure the self-timer is working by glancing at the red signal light just beside the shutter button. If it is winking at you, it is counting off 10 seconds, which it does in twenty winks.

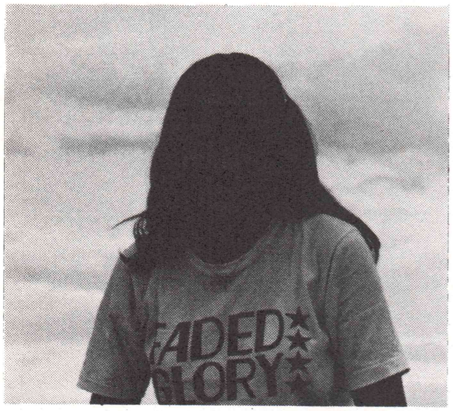
During the time the self-timer is working, point the camera at the scene you intend to shoot. When the exposure is made, it will be at the settings obtained earlier from the substitute metering surface. Because you haven't made any permanent change to camera controls, there is no chance of forgetting to change back again and making following shots with incorrect exposure.

Another way is to take the camera off automatic by moving the aperture-control ring on the lens away from the green 0 or A. In the viewfinder display, observe the aperture setting the camera intends to use on automatic, switch to manual control and set the exposure any way you want it. The display continues to show its *recommended* setting, but you can shoot at any setting you choose. On the next shot, be sure to switch back to automatic. The AE-1 display makes it nearly impossible to forget you have switched to manual because a red letter M flashes four times a second in the viewfinder.

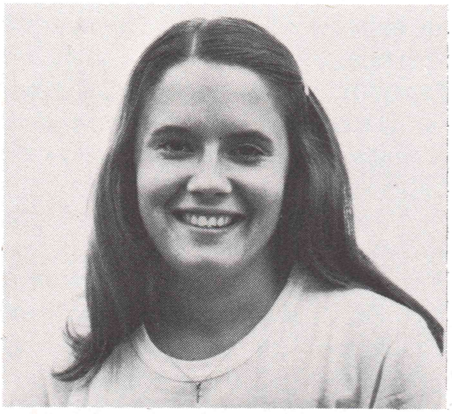
Still another way is to leave the camera on automatic but change the ASA film-speed setting. If you want more exposure, change to a lower ASA number and the camera will think you have loaded slower film. It will do its regular thing and give more exposure than it would if the ASA setting were higher.



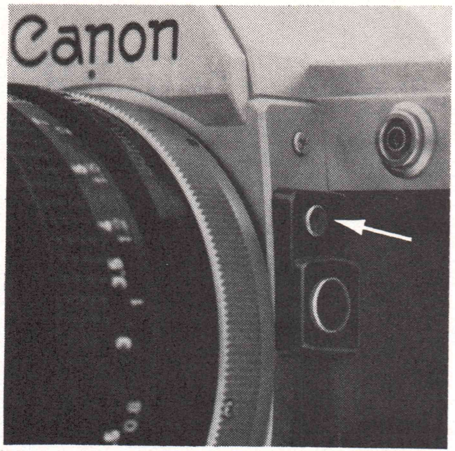
To set an FD lens for automatic operation, rotate aperture ring to align letter A with index. Pushbutton adjacent to A, called AE Lock Pin, must be depressed to make this setting. On early FD lenses, the green mark is an O rather than an A. This setting can't be made unless the lens is on an automatic camera.



With the EF or any camera which meters the entire frame, a bright background can fool the meter into underexposing subject of interest.



Move up close so exposure meter sees mainly the subject of interest and exposure setting should be satisfactory with b&w or color negative film. For color slides which need more precise exposure control, this subject should have one step more exposure than meter indicates because skin and T-shirt are brighter than 18% gray.



When using the AE-1, you can compensate for backlighting without taking the camera off automatic. Depress the Backlight Control Switch (arrow) and you get 1-1/2 steps more exposure than the camera would normally give.

I don't recommend this method because you can easily forget you changed the ASA dial and then all following exposures on the roll may have bad exposure.

The AE-1 Backlight Control Switch—On the left side of the lens mount of the AE-1 are two small buttons. Depressing the top button—the Backlight Control Switch—gives 1-1/2 steps more exposure than the camera would give normally, operating on automatic. This is very convenient for backlit situations such as a portrait against the sky. One-and-a-half stops is a compromise and doesn't suit every backlit situation. After using it a few times, you'll know how and find it handy. Work it with your left thumb while holding the camera normally.

The A-1 Exposure Compensation Dial—You can control the amount of exposure while leaving the A-1 on any of its modes by using a special control which is part of the ASA dial surrounding the Film-Rewind Knob. At most film speeds, the Exposure Compensation Dial has a range of 2 exposure steps in each direction.

The dial is marked with numbers which are exposure *multipliers:* 1/4, 1/2, 1, 2, 4. The normal setting is 1, which means the control multiplies exposure by 1, therefore it doesn't change it. Multiplying exposure by 1/2 reduces it one exposure step; 1/4 is two steps less. Multiplying by 2 is one step more exposure; 4 is two steps more.

To use the control, depress the adjacent Exposure Compensation Lock Button and turn the film-speed dial until the desired amount of exposure compensation is shown opposite the index mark. What this really does is change film speed so the camera gives more or less exposure. However by making the change on a special scale, it is easy to remember that you did it and you never forget what film speed you have loaded into the camera because you don't have to change the actual film-speed setting.

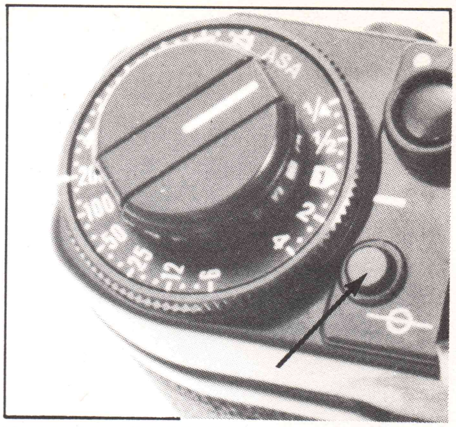
Because the film-speed dial is subdivided into third-steps, the exposure compensation dial is also marked off in third-steps. You must set either dial exactly on one of the marks.

The digital display in the A-1 camera reads in half-steps, so what you see may not exactly agree with what you are doing. Nevertheless, the exposure compensation you set on the dial is what you will get on the film.

When you are not using exposure compensation, be sure to set the dial to 1. If you forget and leave it set for some amount of compensation, it will affect all subsequent exposures until you finally remember to change the setting back to 1. Unless you need special compensation on those frames, exposure will be wrong!

The A-1 Exposure Memory Switch—I mentioned earlier that the EF and A-1 both have a memory hold button. They both keep exposure from changing after you push the button, but they do it in different ways. The EF button just keeps aperture size from changing. The camera trusts you not to change shutter speed, because that would change exposure.

When you depress the Exposure Memory Switch on the A-1, it locks in the *Exposure Value* if you are set for either shutter priority or aperture priority. While holding in the button, you can then change shutter speed as you please and the camera will make compensating changes in aperture to hold the same EV. Or, you can change aperture setting and the camera will change shutter speed to maintain the same EV.



Right side of ASA Film-Speed Dial on A-1 is Exposure Compensation Scale with adjacent Exposure Compensation Lock Button (arrow). Depress lock button to turn compensation dial.

That allows you to do substitute metering and then change your mind about one of the exposure controls without having to go back and meter again.

APPROXIMATE EXPOSURE COMPENSATION FOR SMALL SUBJECT AGAINST VARIOUS BACKGROUNDS

Background	Exposure Change	Dial Reading
Black	2 steps less	1/4
Dark	1 step less	1/2
Average	no change	1
Light	1 step more	2
White	2 steps more	4

USING SEMI-SPOT METERING

Semi-spot metering in the F-1 and FTb is more sophisticated and requires a more aware camera operator. The metering system does not view the entire scene—only the rectangular area indicated on the viewing screen. Within that small area there is also some small amount of center emphasis because the clear microprism area transmits more light than the matte surface which surrounds it.

Semi-spot metering of the F-1 and FTb can be used to meter on a small part of the total scene. In this backlit photo made with an FTb, metering was on the face tone. If necessary, move close to subject, then back up.

The camera will record as middle gray whatever it sees in the metering rectangle. This allows very good control of which tone in the scene appears as the middle tone of the print—you just point the metering area at that particular tone. It's also very easy to do substitute metering.

It also allows some very bad mistakes. If you photograph your friend in a white shirt and the metering falls entirely on his shirt, don't show him the picture. Say, "It didn't come out." Because it didn't.

If you can find a middle tone in the scene, or a small area with an assortment of tones which will average out to a middle tone, and you want a normal picture, put the metering area in the viewfinder over that middle tone to set exposure. Then you can change where you point the camera and the exposure should still be OK.

If you are shooting a scene with light and dark areas but no middle tone, you can take two readings with the semi-spot meter—one on the bright area and another on the dark. The final exposure setting is the average of the two.

How do you average *f*-numbers? Do it by counting exposure steps. The average of *f*-2 and *f*-8 is *f*-4, two steps from each end. If you want to do it by mathematics, you can't take a common arithmetic average because it gives the wrong answer. For example, the *wrong* answer is $(2 + 8) \div 2 = 5$. The correct setting is *f*-4, not *f*-5.

To average *f*-numbers, you have to find the *geometric* average of two numbers. Multiply them together and then take the square root of the result—easy to do if you carry a scientific pocket calculator with you on field trips. Anyway,

$$\sqrt{2 \times 8} = \sqrt{16} = 4.$$

HOW MANY EXPOSURE STEPS CAN A CAMERA MAKE?

That's an interesting question. The F-1 has shutter speeds from 1/2,000 to 1 second. If you use the 50mm *f*1.4 lens, it can close aperture down to *f*-16.

Suppose we set the lens to its smallest aperture and the shutter to its fastest speed. Then move the shutter to slower speeds until we use them all up. Then, at the slowest shutter speed, continue to increase exposure a step at a time by opening the lens until it is fully open. Count the steps. Each *space* between lines in the following table is an exposure step.

f-number	shutter speed	EV number
16	2,000	19
16	1,000	18
16	500	17
16	250	16
16	125	15
16	60	14
16	30	13
16	15	12
16	8	11
16	4	10
16	2	9
16	1 second	8
11	1 second	7
8	1 second	6
5.6	1 second	5
4	1 second	4
2.8	1 second	3
2	1 second	2
1.4	1 second	1

I make it 18 steps, total. Remembering that each step doubles the exposure, the maximum exposure is 262,144 times the smallest, unless I made a mistake in multiplying by 2. I agree that this big number is mainly to "gee whiz" about and has little practical significance.

The number of exposure steps does have practical significance. You should recognize that each of the exposure settings in the preceding list is a definite amount of exposure—different by a factor of two from the one above or below.

To simplify identification of these exposure settings, let's assign a number to each one. The greatest exposure comes from the last setting on that list—1 second at *f*-1.4. Let's call that 1 and assign higher numbers along the series of steps. Setting 19 will be the shortest exposure listed—*f*-16 at 1/2,000.

Those identification numbers are exposure-value (EV) numbers as discussed earlier.

Canon specifies the working range of the exposure-measuring system in EV numbers. The range of the exposure system in the F-1 camera is from EV 2.5 to EV 18—a total of 15.5 exposure steps.

Let's keep separate the exposure steps you can make by different camera control settings and the EV range of the exposure metering system because they are not necessarily the same. If the exposure meter can see 15 steps, but the camera can make 18, the exposure meter cannot work at all camera settings.

It is unusual but not impossible for film to need an exposure which the camera cannot provide. This will never happen due to decreased light because you can always set the camera on B and expose for two or three weeks if necessary.

It may happen when using fast film in a bright light. The film may need *f*-64 at 1/4,000 but the camera can't do that. You will look for a way to reduce the amount of light coming in the lens. When you find it, it will be called a *neutral-density filter* in Chapter 15.

COUPLING RANGE OF THE EXPOSURE METER

This gets complicated, but all you really need to grab is the general idea.

The basic limits in an exposure-measuring system are: When setting exposure or telling you how to do it, the system cannot use any settings that aren't possible. For example, *f*-64 and 1/4,000. Also, the light-measuring sensor cannot be expected to read light levels beyond its range. There is a limit in both directions. The light can be too dim for an accurate reading, or it can be too bright.

Canon publishes tables to show the operating range of the built-in meter. They are called Meter Coupling Range or something similar. For automatic cameras, the meter coupling range limits the operating range of the camera because it depends on the meter to determine exposure settings. If the meter is operating beyond its range, the reading will not be accurate and automatic exposure settings will also be inaccurate.

For some cameras, Canon publishes a rather simple table such as the accompanying one for the F-1.

In the F-1 table, the shaded square shows how to read it. It represents a shutter speed of 1/30, used with ASA 100 film. At the bottom of this column is the smallest aperture that can be used with this film and this shutter speed. The number is *f*-22, which means you can use all of the stops on your lens up to *f*-22. Very few Canon lenses have stops smaller than *f*-22.

For automatic cameras, the meter coupling table uses EV numbers and is more complicated. A table is given for each camera discussed in Chapter 18.

In general, you don't have to worry about finding light so bright the camera can't measure it accurately. If the light is too dim, it is common to work below the metering limit. How each camera warns you of this is covered in Chapter 18.

The meter-coupling limits are not limits on the camera control settings. You can set the camera any way you wish, but if you operate outside the coupling range of the meter, you are on your own as far as exposure is concerned. All Canon SLR cameras work this way, but the meter-coupling limits vary among different models.

USING EV NUMBERS TO SPECIFY EXPOSURE-METER RANGE

We encounter a minor complication here. EV numbers basically represent combinations of shutter speed and aperture. But there are two additional factors that affect exposure on film: the amount of light from the scene and the film speed. Four things affect exposure and an EV number expresses two.

When we use an EV number to specify the operating range of an exposure meter, we really mean to specify the upper and lower limits of *light coming from the scene* into the lens. If the light is within those limits, the exposure meter reads accurately. If the light is outside of those limits—too bright or too dim—the meter will not read accurately although it may give you a reading.

To state a metering range, camera makers give EV numbers and also specify maximum aperture of the lens and the film speed. When this is done, the EV range becomes the light-measuring range. Here's how all four of the things that affect exposure are handled:

Because modern SLRs meter at maximum aperture, it is assumed that the lens is *always* set at maximum aperture.

With aperture identified, the EV number itself identifies a shutter speed.

Film speed is stated as part of the metering-range specification—usually ASA 100.

Light from the scene is the only factor left, so it is identified by stating the other three factors and making one more assumption. We assume that the amount of light gives correct exposure of the film.

F-1 COUPLING RANGE OF BUILT-IN EXPOSURE METER

FILM SPEED	SHUTTER SPEED											
ASA 25	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000
ASA 50	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000	---
ASA 100	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000	---	---
ASA 200	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000	---	---	---
ASA 400	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000	---	---	---	---
ASA 800	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000	---	---	---	---	---
ASA 1600	1/60	1/125	1/250	1/500	1/1000	1/2000	---	---	---	---	---	---
Minimum *f*-stop	*f*-22	*f*-22	*f*-22	*f*-22	*f*-22	*f*-22	*f*-22	*f*-22	*f*-16	*f*-11	*f*-8	*f*-5.6

You can shoot at camera settings outside this meter coupling range, but you have to figure exposures yourself.

Let's do it once with numbers. The meter-coupling range of the A-1 camera is EV -2 to EV 18 with an *f*-1.4 lens and ASA 100 film. Let's examine the lower metering limit.

Because the lens is *f*-1.4, we can find shutter speed for EV -2 in the EV table on page 28. It's 8 seconds. Film speed is ASA 100.

The lowest light level at which the camera can meter is the amount of light from the scene that gives correct exposure to ASA 100 film with an *f*-1.4 lens wide open and a shutter speed of 8 seconds.

In the earlier discussion of programmed automatic exposure on page 35, I said the A-1 program can't use exposures longer than 8 seconds with ASA 100 and *f*-1.4. That's because the meter doesn't work accurately below EV -2.

What About Different Lenses and Film Speeds?—A metering range is usually given for *f*-1.4 and ASA 100. But you are using an *f*-2 lens with ASA 200 film. How do you figure the correct metering range? Let's consider the changes one at a time.

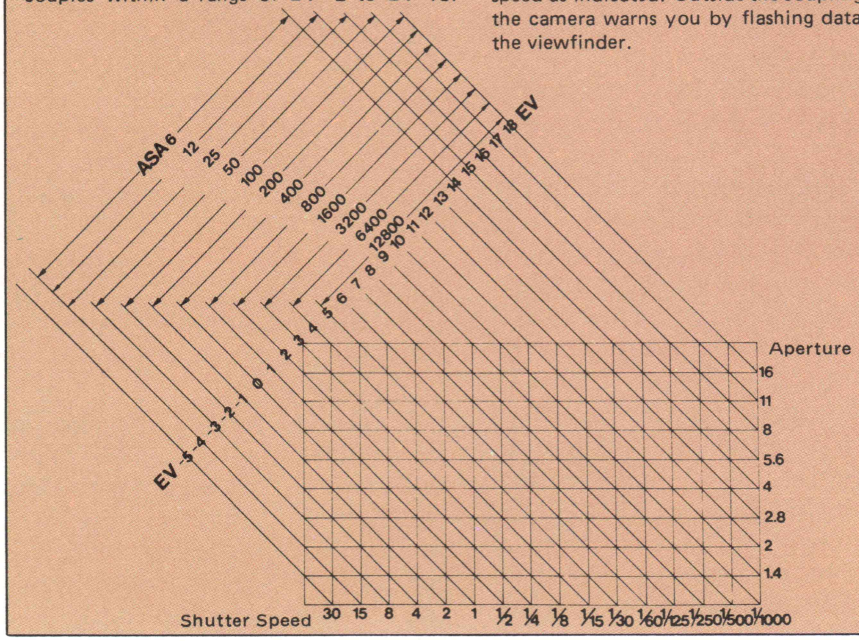
An *f*-2 lens can't open up as much as an *f*-1.4. The camera compensates by using one step slower shutter speed, so the EV limit remains at EV -2 as long as the camera has slower shutter speeds. When the slowest speed has been used, *then* the lower limit goes up step by step as aperture is made smaller.

The next part requires some tricky reasoning. If the amount of light specified by the EV numbers gives correct exposure with ASA 100 film, what will it do with ASA 200 film—which *needs* one step less exposure? Suppose you have the camera all set for correct exposure and then you change the film from ASA 100 to ASA 200, and change nothing else. Obviously the ASA 200 film will be overexposed by one step. To make the light right for ASA 200, you must either close aperture one step or switch to a shutter speed that is one step faster. It doesn't matter which you do, as long as you do only one. The resulting EV number goes up one step.

A-1 METER COUPLING AND AUTOMATIC EXPOSURE RANGE

Meter Coupling Range
When using the FD 50mm *f*-1.4 S.S.C. lens and ASA 100 film, the built-in exposure meter couples within a range of EV -2 to EV 18.

AE Coupling Range
At indicated film speeds, the built-in exposure meter couples with the aperture and shutter speed as indicated. Outside the coupling range, the camera warns you by flashing data inside the viewfinder.



The EV metering range also goes up step by step with film speed increases, remembering that doubling film speed is one step.

This discussion of how metering limits move up and down with film speed is theoretical and also practical within limits. In an actual camera, the lower EV limit won't go down indefinitely with lower film speeds and the upper limit won't go above EV 18 with higher film speeds. This is because the light sensor in the camera has limits and you can't work beyond those. You can see these absolute limits in the accompanying AE Coupling Range graph for the A-1.

METERING AIDS

For low light levels, beyond the coupling range of the built-in meter, Canon offers two attachments to help the camera meter in the dark. The Canon Booster fits the FTb. The Booster T Finder for the F-1 will also control shutter speed for long exposures.

Another attachment for the F-1 is the Servo EE Finder. The letters EE are a hangover from the days when *Electric Eye* was a term used for metering in the camera. This converts an F-1 to automatic operation with shutter priority. It does not extend the EV range of the camera, but it changes the metering of the F-1, so it seems logical to discuss it here.

CANON BOOSTER

The Canon Booster for FTb cameras increases meter sensitivity from EV 2.5 down to EV -3.5—15 seconds at *f*-1.2—an increase of 6 steps.

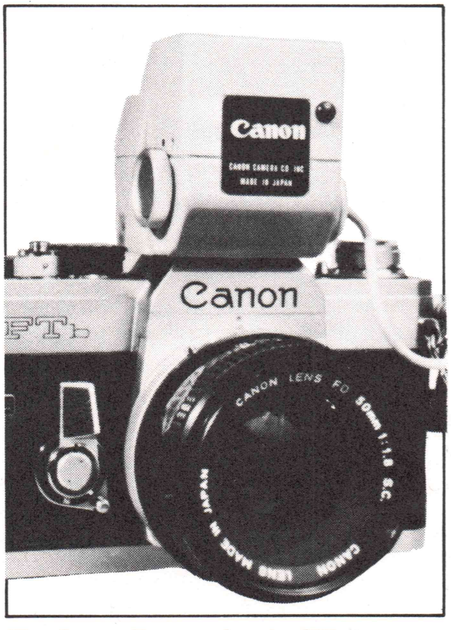
The booster is a self-contained exposure meter, except that it uses the FTb's built-in light sensor. Underneath the battery in the battery compartment of the FTb is a socket connector for a 2-prong plug. The connecting cable from the booster plugs into this socket after the battery and cover are removed. This takes the electrical output signal from the light sensor in the camera and delivers it to the booster. The sensitivity of light metering is increased because the booster electronics give greater amplification of the weak signal from the camera sensor.

The booster mounts on the hot shoe of the camera but doesn't make any electrical connections there.

After taking the electrical signal from the camera light sensor and amplifying it, the booster reads out exposure settings for the camera at whatever amount of light it has measured. It does not make any camera settings; you read them and dial them into the camera yourself.

The sensor in the FTb camera is cadmium-sulfide which responds slowly in dim light. Operation with the booster is suited for relatively slow and careful work in dim light with the camera on a tripod. At the lowest light levels the meter reading stabilizes so slowly that a 2 to 3-minute wait is recommended before taking the final exposure reading.

The general procedure is to focus on the scene, using a flashlight or other temporary illumination if necessary. Then close off the viewfinder window of the camera with a hinged cover which is part of the booster. This prevents stray light from entering the camera through the viewfinder window and affecting the reading of the sensor.



The Canon Booster for the FTb increases light-measuring sensitivity by 6 exposure steps.

A meter on the top of the booster is used to obtain exposure settings. Push a button to illuminate this meter so you can see it in poor light. The information you must set into the booster for it to operate properly is: Type of camera—FTb or certain earlier models—and film speed.

The booster must work at stopped-down aperture because there are no mechanical connections between the lens and the metering system in the booster. Therefore, to take a reading, use the Stopped-Down Lever on the camera body and the Lever Lock button to lock it in stopped-down operation. Then when you select an aperture, the light immediately changes to the value allowed by that aperture.

With that done, and a shooting aperture selected which you think may work, find shutter speed by balancing the meter display in the top of the booster case. There is a moving needle and a fixed circle in the middle of the meter window.

Rotating the shutter-speed dial on the booster causes the meter needle to move left or right. Turn the shutter-speed dial until the needle passes through the fixed circle at the center of the meter window. Read the shutter-speed dial against its index mark and that is the shutter speed you should set into the camera for proper exposure according to the amount of light and the film speed.

This does not take reciprocity failure into account and you should consult the film data sheet or manufacturer. If you have no data on reciprocity-failure correction, try exposures at a half step, full step, and two steps over the booster meter recommendation.

You cannot conveniently switch back and forth between the camera's built-in system and the Canon Booster, so there is some overlap of capability. If you are working in light just below the metering range of the FTb, it is possible that for some shots the light could drift back and forth in the region just above and below what the FTb can meter by itself. To avoid such frustrations, the booster will read shutter speeds from 1/60 second to 30 seconds. The steps from 1/60 to 1 second cannot be read from the camera display with the booster in place, but can be read from the booster. If the light requires exposures shorter than 1/60, you probably have no need for the booster on the camera anyway.

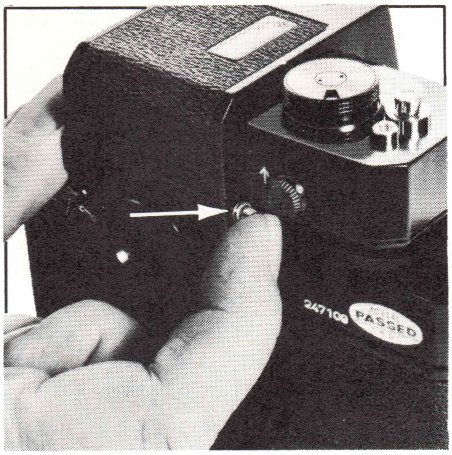
The booster has a coupling range the same as any other exposure meter, indicated in this case by limits of shutter-speed-dial rotation of the booster. If you want to use an aperture and shutter-speed combination beyond the booster's coupling range, try to find a reading at a different aperture and then count steps to the desired settings. Don't get carried away and forget about reciprocity failure.

If the booster recommends shutter speeds from 1/60 to 1 second, the camera itself will time the exposure when you set the desired time into the camera and operate the shutter. If the booster calls for shutter speeds longer than 1 second, put the camera on B; control exposure time manually.

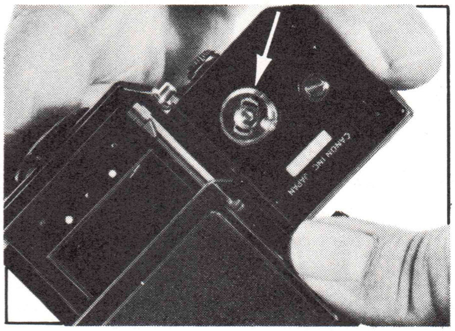
Even though exposure metering *seems* to be in the booster attachment on top of the camera, it is actually operating with the camera sensor and optics. Before you close off the viewfinder window to take the booster reading, be sure the semi-spot meter is looking at an appropriate tone of the scene: You can use substitute metering.

The booster may suggest shutter speeds below the coupling range of the camera metering system for the film speed being used. You can set those speeds into the camera and it will produce them. The red flag at the bottom of the camera display will be up, but with the viewfinder window of the camera covered, you aren't supposed to know it or worry about it. The red flag doesn't mean exposures at low shutter

The Booster T Finder for the F-1 increases light measuring sensitivity by 6 exposure steps. With the T finder installed, you can still use normal camera metering at higher light levels.



Remove the camera pentaprism and replace with the Booster T Finder. A squeeze-button (arrow) on the finder latches it in place. The shutter-speed dial on top of the Booster T couples mechanically to the shutter-speed dial on the camera.



Shutter-speed dial coupler (arrow) is on the bottom of the T finder. Beside it is a plunger which operates the shutter-release button on the camera.

speeds are not possible, it just means you can't meter them with the camera built-in system.

BOOSTER T FINDER FOR THE F-1

The F-1 pentaprism is removable so different viewing screens can be used and to allow attachment of accessories. To install the Booster T Finder, remove the pentaprism and replace it with the finder.

This accessory has its own built-in pentaprism and viewing window for eye-level viewing. Except when the viewing window must be closed at low light levels to block stray light, you view through it just the same as the normal F-1 viewfinder and pentaprism.

With the Booster T Finder in place, the camera is equipped with two separate light-metering systems, each with its own sensor. Neither disables the other, although they are not used simultaneously.

The camera light sensor continues to receive light from the inclined beam splitter in the condenser lens above the viewing screen. It continues to work as a semi-spot meter and is unaware of the presence of the T finder, farther along in the optical path.

The T finder uses two cadmium-sulfide photocells arranged to view the entire screen. It is a full-field integrating meter which responds to all light in the frame. You always know which metering system is in use, but should be aware that one is semi-spot and the other is full-field, because you meter differently with the two types.

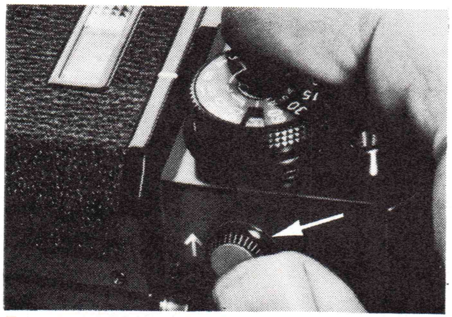
The EV range of the camera exposure meter goes down to 2.5. The T finder meter begins at 1.5—the next step lower—and continues down to -3.5, adding an additional six steps of meter sensitivity. You use one or the other according to how much light there is, and it is convenient to switch back and forth. The T finder displays the camera readout when you are using the camera meter. When in the T finder range, the camera read-out is not visible and you use a meter indicator on the top of the T finder in a way similar to the FTb Booster described earlier.

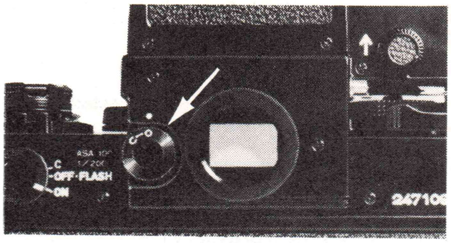
When the Booster T finder is installed on the camera, a mechanical coupling is made to the shutter-speed dial on the camera body. Shutter speeds are selected by rotating a dial on top of the T finder, thereby turning the shutter-speed selector on the camera itself due to the mechanical coupling. This works down to shutter speeds of 1 second.

When the shutter-speed dial on the T finder is turned to select its next longer speed below 1 second, the dial indicates 3 seconds. The shutter-speed dial on the camera—hidden underneath the Booster T finder—is set at B, which is as far as the knob on the camera can be turned.

To select even longer shutter speeds, the mechanical coupling between the knob on the T finder and the shutter-speed knob on the camera is disconnected by moving a button on the T finder. This leaves the camera shutter speed set at B while the T finder control can be set at shutter speeds as long as 60 seconds.

With the T finder in place, the shutter button on the camera is covered up. A shutter-release button on top of the T finder is mechanically coupled to the shutter button on the camera. For shutter speeds down to one second, the shutter is released by the button on the T finder but shutter operating time is controlled by the normal timing mechanism inside the camera. For shutter speeds from 3 to 60 seconds, the camera is on B and exposure timing is done by the T finder. Depress the shutter button on the T finder; it depresses the shutter button on the camera and holds it down for the desired length of time. A lamp in the top of the T finder blinks at intervals of one second to remind you it is on the job and the exposure is underway.


For shutter speeds of one second and shorter, shutter-speed dial on T finder controls position of shutter-speed dial on camera. Exposures are timed *by the camera.* For exposure times of 3 seconds and longer, camera shutter-speed dial is left on B and shutter-speed dial on T finder is disconnected from camera by sliding button upward as shown. T finder can then select shutter speeds from 3 seconds to 60 seconds, which *it* times automatically by holding down the shutter-release button on the camera.



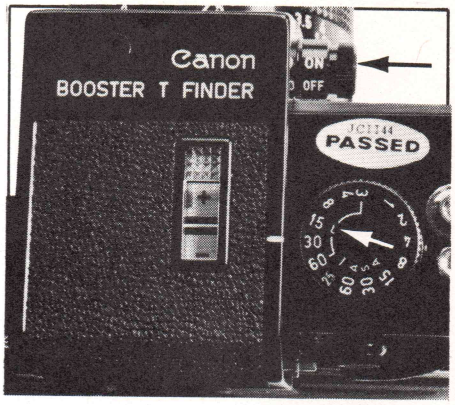
After composing the picture, close viewing window aperture before metering to prevent stray light from affecting reading. Control labeled C-O closes and opens window.

The upper limit of shutter speed when using the T finder is 1/60 second. This is only because part of the shutter-speed dial on the T finder is used for slow speeds, so faster speeds above 1/60 have to be omitted.

The general operating procedure is as follows: Set film speed into both camera and T finder. The procedure at the T finder is similar to that at the camera. Attach finder and look into the viewfinder window. If shutter speed is set for one second or less, the camera does the metering. The camera exposure indicators will be illuminated and visible in the T finder window. Operate the camera just as if the T finder was not attached, except that you use the shutter-speed selector and shutter-release button on top of the finder instead of on top of the camera.

When using camera metering, you can meter at full aperture or stopped-down, as you choose.

When you select a shutter speed below 1 second—B on the camera dial—the camera exposure display is no longer visible. That tells you to turn on the T finder main switch.



Low-speed range of T finder is indicated by L on shutter-speed dial and by marking low-speed numerals in orange. Numerals for speeds of one second and shorter are white. To meter at 3 seconds or longer, turn main switch (arrow) ON. Set aperture, then adjust shutter-speed dial until meter needle on top of finder is centered. Index shows shutter speed.

View and focus through the T finder and then use a control on the finder to move an internal shutter across the finder window to block stray light. The same control turns on the T finder metering circuit and lights a meter lamp on top of the finder. You can no longer view the scene through the finder window.

The exposure meter on top of the finder has a moving needle and a black band in the center. The only connection between lens and meter in the T finder is light rays, so the T finder doesn't get any information from the pins and levers in the lens mount. Therefore, T finder metering must be done stopped-down. Use the Stopped-Down Lever on the camera and lock it.

Then operate the aperture ring on the lens or the shutter speed dial on the T finder so the moving needle lines up with the black band in the center of its range. To compensate for reciprocity failure, note the T finder recommendation for exposure and then add some—either by larger aperture or longer time. After you have made the correction, push the shutter-release button on the T Finder and it will automatically time the exposure.

As with all exposure meters, there is a limit to coupling range. The usual ways to cope with it can be used. Try different aperture or shutter speed to get a reading then count steps to whatever you want.

COUPLING RANGE OF BOOSTER T FINDER			
Film Speed ASA	Usable Shutter Speeds		Usable Range of Aperture
	Metering by the Booster	Metering by the Camera	
25	60–3	1–1/60	*f*-1.2–22
50	30–1	1/2–1/60	*f*-1.2–22
100	15–1/2	1/4–1/60	*f*-1.2–22
200	8–1/4	1/8–1/60	*f*-1.2–22
400	4–1/8	1/15–1/60	*f*-1.2–22
800	3–1/15	1/30–1/60	*f*-1.2–22
1600	1–1/30	1/60	*f*-1.2–22
3200	1/2–1/60		*f*-1.2–22
6400	1/4–1/60		*f*-1.2–22
12800	1/8–1/60		*f*-1.2–22

You can use exposure settings outside the metering range of the Booster T Finder, but you should meter inside the range and then change settings.

You can fool the system by dialing in a film-speed number different than what you actually have in the camera. This requires some elaboration and a more complete discussion will happen in a few more pages.

A peculiarity of the relationship between Booster T Finder and camera is, the T finder can be set for film speeds up to 12,800 whereas the F-1 has an upper limit of 2,000 or 3,200 depending on when it was manufactured. The two film-speed dials are independent of each other.

If you have both set at the same film speed, you can switch back and forth between camera metering and Booster T metering with no problem. If you have the Booster T set for a higher film speed than the F-1 can reach, then you should set the camera to its highest possible setting but there will be a problem.

The problem is, the Booster T Finder will operate at the film speed you have set into it, when it is doing the metering. If you switch to camera metering, it will work at the speed you have dialed into the camera. Exposures will not be correct for one condition or the other.

This situation is unusual. One solution is to expose the entire roll with Booster T metering if you are rating the film higher than the F-1 dial will allow.

Full-field metering when using the Booster T metering system is satisfactory for most shooting situations when the user is aware he is using it. It is probably the best choice for the Booster T because dimly lit scenes often include bright lights, such as street lights, building illumination, or the moon. With semi-spot metering, a bright light in an otherwise dark scene which happened to fall in the metering area would dominate the metering system of the camera and cause drastic underexposure of the remainder of the scene. Full-field metering averages such bright spots with the larger dark area and the resulting exposure is more likely to be satisfactory.

SERVO EE FINDER

This also replaces F-1's normal pentaprism and is for the F-1 only. It converts the F-1 into an automatic shutter-priority camera with great similarity to the EF, except the EF works down to EV-2. The F-1 has the same meter limit with or without the Servo EE Finder: EV 2.5.

The Servo EE Finder installed in place of the normal pentaprism couples to the shutter-speed dial of the camera in the same way as the Booster T. It also has a film-speed selector which should be set to the same number as on the camera. The range of available shutter speeds is the same as the F-1.

The EE Finder completely replaces the exposure measuring system of the F-1 although the F-1 will continue to measure exposures invisibly unless you turn the meter switch off on the camera body. The display you see in the EE finder is similar to that of the EF camera—a moving needle over a set of aperture numbers, indicating the aperture the EE unit is selecting automatically.

Exposure metering is performed in the EE Finder, using its own cadmium-sulfide photocell to view the entire screen with increased sensitivity near the center and below center—Central Emphasis.

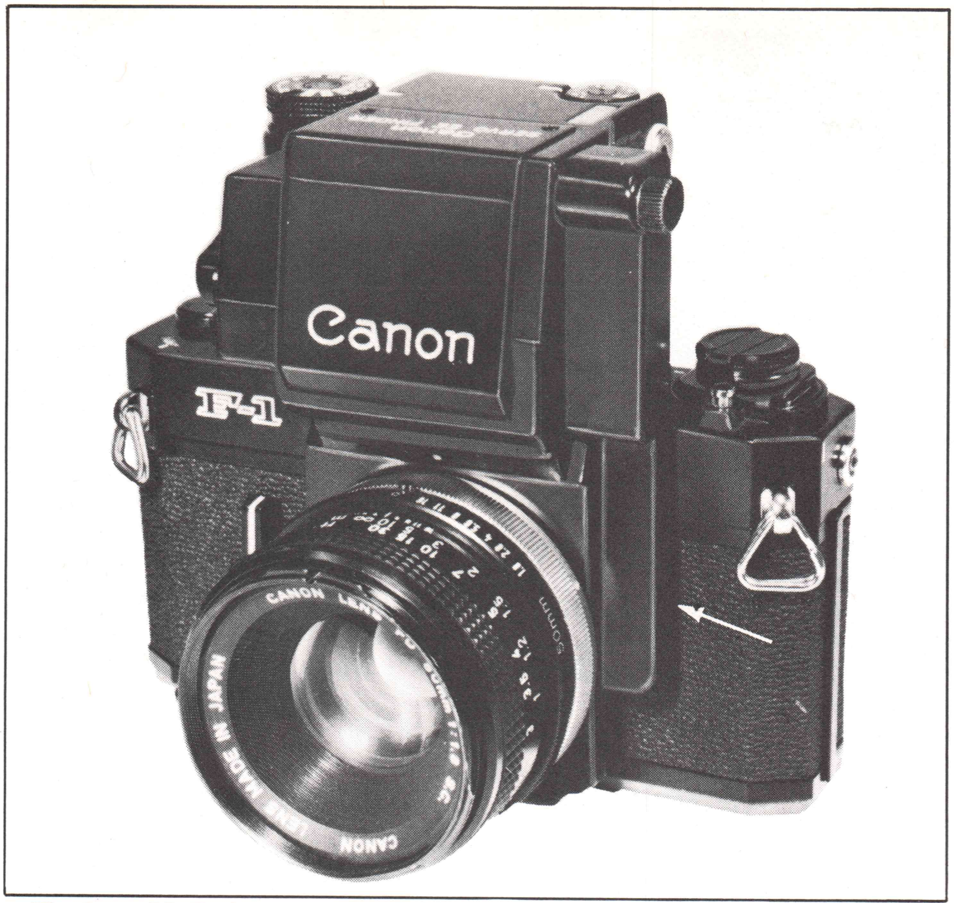
A coupling arm extends from the EE finder down to the camera body. This mechanical link connects an electric motor in the EE finder to the aperture-control mechanism of the lens. Thus the finder motor can regulate lens aperture.

Metering is full-aperture, just as with the F-1, and FD lenses must be used. Full-aperture lens information must be dialed into the EE unit. A small selector includes maximum apertures for all Canon lenses. You set this dial for the maximum aperture of the lens in use which causes the EE finder display to change so the maximum aperture of the lens is the largest aperture shown in the display.

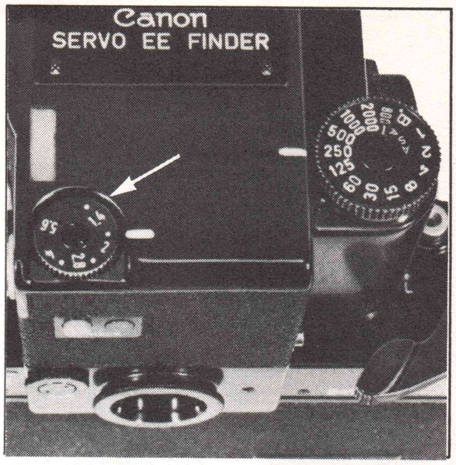
At the other end of the *f*-number display, *f*-22 appears or disappears automatically, depending on the maximum aperture you have set into the finder.

Electrical power for the EE Finder is derived through a coiled cable from a separate battery case which you wear, or locate near the camera if unattended and stationary.

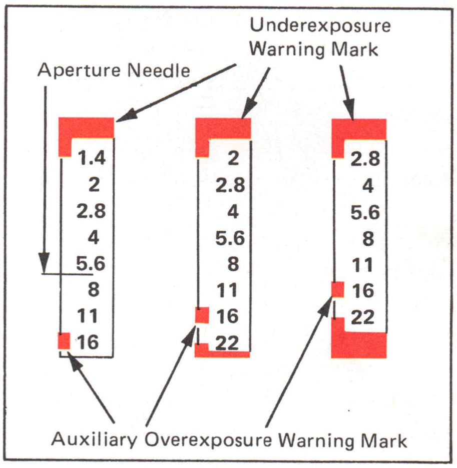
A control knob closes off the viewfinder window. Its use is optional and not interlocked with any other system. You should close



The Servo EE Finder converts an F-1 into an automatic shutter-priority camera. An electric motor in the finder unit controls lens aperture by a control arm (arrow).



Shutter-speed dial of EE finder couples to camera but does not extend range of shutter speeds. Lens Speed Adjustment Dial (arrow) must be set to maximum aperture of lens being used.


Underexposure Warning Mark
Aperture Needle
1.4
2
2.8
4
5.6
8
11
16
2
2.8
4
5.6
8
11
16
22
2.8
4
5.6
8
11
16
22
Auxiliary Overexposure Warning Mark

Viewfinder display in Servo EE Finder changes according to setting of Lens Speed Adjustment Dial. For maximum apertures of *f*-2 and larger, display only reads to *f*-16 because Canon lenses with apertures of *f*-2 or larger have minimum apertures of *f*-16. Moving needle shows aperture being selected by finder. Underexposure band is at top.

Most Canon lenses with maximum apertures of *f*-2 or smaller may have minimum apertures of either *f*-16 or *f*-22. Display appears as shown at right. Overexposure mark near *f*-16 is used for lenses with minimum aperture of *f*-16; mark near *f*-22 is used for lenses with *f*-22.

the window to prevent stray light entry and inaccurate exposure readings when your eye is not blocking light.

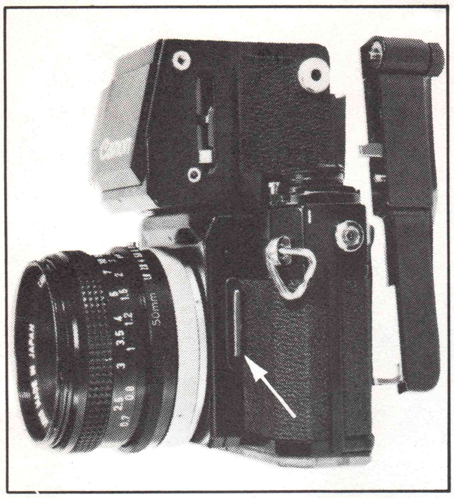
The operation is to view and focus using the viewfinder window. Select the shutter speed you want to use. The main switch has three operational positions, M, L, and a red dot. M disables the automatic feature and allows normal manual operation of the lens as if the EE Finder was not in place. Position L turns on the automatic operation and locks it on. The electric servo motor in the finder then continuously adjusts aperture in accordance with the amount of light entering the lens.

Battery drain is higher when the servo motor operates continuously and this setting should only be used when the camera is unattended or when you are using it to shoot as fast as possible, such as photographing action in varying light.

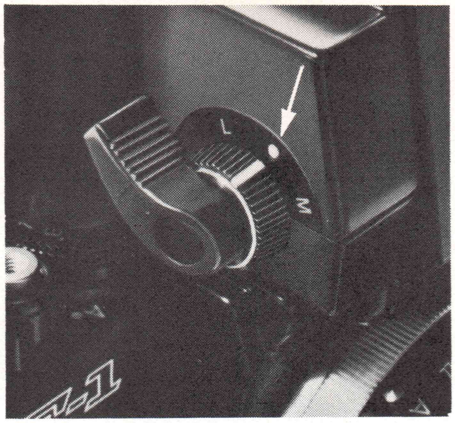
An alternate method of turning on the automation is a lever associated with the main switch. It is used with the main switch set to the red dot. This spring-loaded lever switch energizes the motor and allows it to control aperture only as long as you hold the lever down. You can hear the motor operating, so when you hear it stop, you know aperture is set for the scene in the viewfinder. Release the lever and the aperture is locked at that setting. You can then shoot the picture when you please, but the motor no longer runs down the battery.

Use of the lever control also allows you to set exposure by substitute metering on a tone not in the scene, lock the aperture by releasing the lever, and then turn the camera to the scene you plan to shoot.

The automatic aperture control is so fast that you cannot shoot at shutter speeds slower than 1/15 second. If you do, the mirror



To attach control arm, open small trap door on camera body (arrow), set control on M. Control arm is held in place by screw at top of arm.



Control of Servo EE Finder is by knurled ring or associated lever. Ring set on M allows manual operation; on L servo is locked for continuous motor control of lens aperture; red dot (arrow), turns servo off and enables use of lever. Depressing lever turns on aperture-control motor momentarily so unit will set aperture for amount of light from scene.

blocks light to the finder as it swings up and the servo motor will open aperture due to the decreased light before the shutter operates. The film will be overexposed. An exception to this is when a motor drive is used, because of a special feature of the motor drive.

A precaution relates to use of the main switch at the M setting for manual control of aperture. It allows manual control, but does not turn off the motor, so battery drain continues. For short periods, this battery drain is tolerable.

Switching to manual control is another way to override automatic aperture selection. You can observe the viewfinder display to notice the *f*-stop the finder plans to use. If you don't want that setting, switch to M, choose the aperture you wish to use and make the exposure. Then return to the red-dot setting to switch off motor power and use the lever to switch on the motor when needed.

For long-time manual operation of the aperture, remove the Servo EE Finder and use the F-1 in the normal way.

For the F-1 owner, purchase of this finder should be decided by whether or not you need it. Which is not exactly deep thinking. For unattended use with a motor drive, it is essential unless the shooting light is constant.

When shooting quickly with variable light on the subject, automatic exposure control is at least handy and sometimes essential.

FILM SPEED AS AN EXPOSURE CONTROL

ASA film speed is a message from the film manufacturer to the exposure calculator in your camera, requesting a certain amount of exposure. With a non-automatic camera, the film receives that amount of exposure if you satisfy the viewfinder display. With an automatic camera, the film gets that exposure if you stand back and let the camera do it.

You don't have to use the ASA speed number as an input to the camera—you can use whatever you choose. If you dial in a higher or lower speed number, then you are not using the ASA number but you are using your own exposure index to guide the camera.

If you have selected 32 at the camera when the film is ASA 64, the camera is set to give one step more exposure than it would if you dialed in 64—provided you have balanced the exposure display at the speed setting of 32.

This is not necessarily a wrong exposure. Suppose you have performed substitute metering using your precision palm which reflects 36% of the light. To use your palm instead of a gray card, you meter on it and open up one step.

There are three ways to change the camera settings so the film will get one step more exposure: Increase aperture, decrease shutter

YOUR OWN PERSONAL EXPOSURE INDEX—The film manufacturer announces the official ASA film speed of his products. Nobody can argue because it's the manufacturer's privilege to test and decide on ASA film speed.

You don't have to use it. If you use a different number, then you are not using ASA speed. The different speed number is commonly called an *Exposure Index,* sometimes abbreviated EI.

Dedicated photographers sometimes make tests to find a film speed for a particular brand and type of film which seems best for that film used in the photographer's camera, judging the results according to personal taste or preference. Making such a test is simple. Shoot at higher and lower speed settings than ASA and see what suits you best. Make notes about the exposure of each frame or, better still, put a small sign in the picture for an unmistakable record of the speed number used for that frame.

With color slide film, underexposure of about one-half step makes the colors more saturated. Some photographers do this by using an EI which is higher than ASA. The visual effect of more color saturation is that colors seem stronger and more emphatic.

If you have a new camera, it's worth testing speed settings higher than ASA while using color slide film. For example, try EI 32 with ASA 25 film. Then evaluate the results in your slide projector, intermingling the test slides with others that have normal exposure. You may find that you like *slightly* less exposure than the camera will give using ASA film speed.

Double exposures are fun. This shot brought back the essence of our family vacation on a Colorado ranch.

speed, decrease the film-speed number.

If you decide to change the speed dial from 64 to 32 as a way of adding one step, what happens inside the camera? It depends on the camera. Among the non-automatic cameras, when you change the film speed setting from 64 to 32, the Meter Needle will move an amount equivalent to one step. That didn't change the exposure yet because you haven't yet changed *f*-stop or shutter speed. After the needle moves, you have to balance the display once again by changing either aperture or shutter speed. When you do that, exposure will increase by one step.

Why not just change aperture or shutter speed directly, without going through the rinky dink of altering film speed? No reason at all except you end up shooting with the needles not matched. I do it all the time.

The first few times you shoot without a balanced exposure display, you feel like a nervous lawbreaker. But eventually you become a hardened criminal.

Film speed is an exposure *control* only if the camera exposure is set according to the film speed you have dialed in. An automatic camera responds automatically to a changed film speed, so it is a control. A manual camera responds to a changed film speed only if you balance the exposure display to the new speed. Therefore it may or may not be an actual control. If it isn't a control, what is it?

When film speed is not a control, it is either an aid to calculation or a mechanism fooler.

Coupling range is affected by film speed. You can sometimes change film speed to get an exposure reading at the shutter speed you want; then compensate for the fact that you took the reading at the wrong film speed.

With the Booster T Finder, some shutter speeds are not available, depending on film speed selected. It is possible to take a reading using the correct film speed, increase exposure time mentally to compensate for reciprocity failure and then find you can't get the shutter speed you want. Change the film speed dial to ASA 25 and all possible shutter speeds are available. Shoot, then change film speed back to the correct value for the next exposure reading.

Another use of film speed is to deliberately underexpose or overexpose an entire roll. It is common to shoot with a higher than ASA film speed set into the camera. This amounts to deliberate underexposure but many photographers don't think of it that way. They say, "I am rating this film at a higher speed, so I can use it in dim light." Even so, it's still underexposed.

When you shoot any part of a roll with a higher speed number that requires special processing, you should expose the entire roll that way. It is convenient to change the film-speed setting and leave it that way for the entire roll. That way you use the camera display normally and you don't have to remember not to. You also need to remember to mark that cartridge so it won't get mixed up with the rest of your film.

DOUBLE AND MULTIPLE EXPOSURES

If a subject against a *dark* background is photographed with normal exposure, the film frame can be considered as two distinct areas. The area of the subject is normally exposed. The dark background caused little or no exposure on the film.

A second subject against the dark background can be photographed on the same frame, also with normal exposure *provided* the areas on the film occupied by the two subjects do not overlap.

Now the film frame can be considered as three areas. One for each subject and some still unexposed or underexposed background. Obviously a third subject could be placed in the unused dark background area and normal exposure could be given to the third subject.

The rule for multiple exposures against a *dark* background where the subjects *do not overlap* is to give normal exposure to each shot.

When subjects do overlap, the situation is different. Normal exposure of two subjects occupying the *same* area on film amounts to twice as much exposure as that area needs—one step too much. Three overlapping exposures give three times as much total exposure as the film needs, and so forth.

With overlapping subjects, the rule is to give the correct *total* amount of exposure to the film, allowing each individual shot to contribute only a part of the total. If there are two overlapping images, each should receive one-half the normal exposure. Three overlapping images should each receive one-third the normal exposure, and so forth.

This is done by dividing the normal amount of exposure for *each* shot by the total number of exposures to be made. Please notice: This *does not* require each exposure to be the same. Measure for each exposure, divide by the number of exposures to be made, and give the resulting amount—whether or not it is the same as some other subject requires.

This procedure tends to give normal exposure to the *combined* image on the film, but each individual image is less bright according to how many shots there are. If you make more than three exposures, each individual image becomes pretty dim, but the effect is sometimes pleasing anyway. Also, even though the background is dark, it will get lighter and lighter with successive exposures.

RULES FOR MULTIPLE EXPOSURES

Dark uncluttered backgrounds are preferable.

The background gets lighter with each exposure.

If there is no image overlap, give normal exposure to each shot.

If there is image overlap, divide the normal exposure for each shot by the total number of shots to be made.

A handy way to adjust exposure is, multiply film speed by the planned number of shots and set the nearest available speed on the camera dial. Then use the camera normally for each shot.

Don't forget to reset film speed afterward.

You can also adjust exposure by changing shutter speed or aperture.

OPERATING THE CAMERA FOR MULTIPLE EXPOSURES

Cameras prevent *accidental* double exposures by a mechanical interlock which requires advancing the film before each shutter operation.

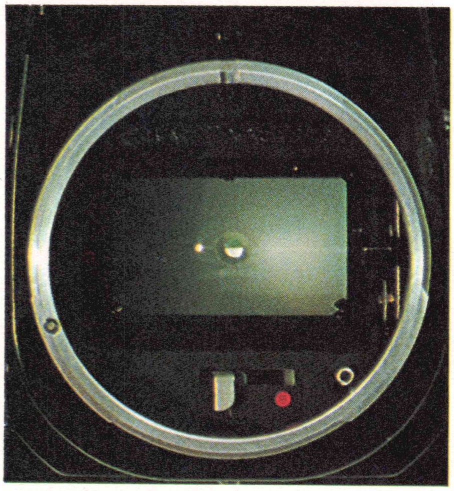
The procedure for deliberately making multiple exposures varies among cameras and is described for each model in Chapter 18.

LENS-MOUNTING MISTAKES TO AVOID—Before attaching a lens, be sure the knurled Breech-Lock Ring at the back of the lens is rotated fully counterclockwise. Early FD lenses don't have the Mount-Lock Pin which holds the ring in the "open" position. With these lenses, it's easy to turn the Breech-Lock Ring a small amount accidentally and then find that you can't mount the lens.

When an FD lens is set for automatic operation, the tiny EE Lock Pin projects from the lens mounting surface, partially concealed by the Breech-Lock Ring. If this pin is projecting, the lens will mount only on cameras which have a corresponding hole in the mounting flange on the camera. If you have any other camera model, be sure the lens is not set on automatic before you mount it.

Never operate the camera Stopped-Down Lever and lock it without a lens on the camera. If you do, the Stopped-Down Coupling Lever moves to the far end of its travel and will not mate properly with the lens. The camera will not stop down automatically during exposure.

A red dot is engraved on the camera body, just behind the Stopped-Down Coupling Lever as shown in the photo. If the lever is in the wrong position, the red dot is visible. If you see the red dot, don't mount the lens. Unlock the Stopped-Down Lever, then mount the lens.



13

CLOSE-UP AND MACRO PHOTOGRAPHY

Two different types of accessory items are used in close-up and macro photography. They will be discussed separately with the simple theory of how each of these devices works. After that, application is easy.

MAGNIFICATION OF A NORMAL LENS

A 50mm lens used by itself on the camera has greatest magnification when focused on the closest possible subject. Closest focus with the normal lens is a little less than 0.6 meters, which is the closest marked distance on the focusing ring. This distance is measured from the film-plane indicator mark on top of the camera body.

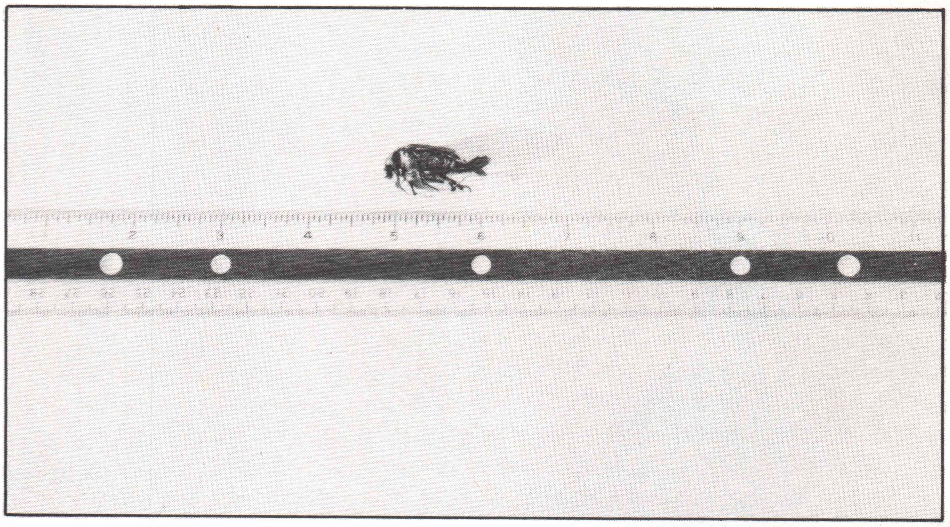
To focus at the closest distance, rotating the focus control moves the 50mm lens away from the film by about 5mm, so the distance from lens node to film becomes about 55mm.

Under these conditions, magnification is approximately 0.11—the image on the negative is about 11% as tall as the subject.

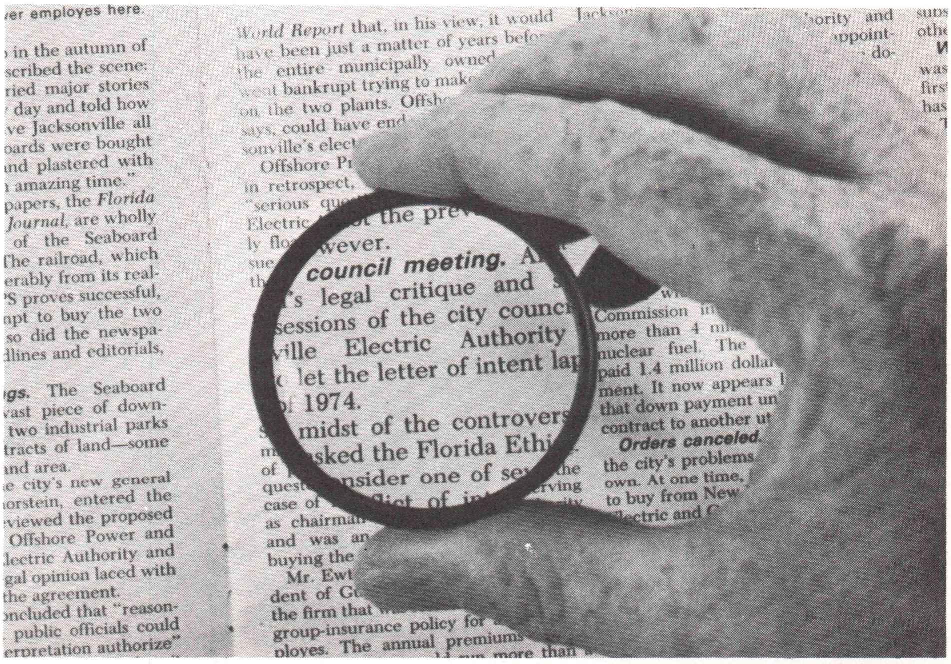
CLOSE-UP PHOTOGRAPHY

Close-up photography begins at about the same place normal lenses leave off. Close-up photography starts at a magnification of about 0.1 and extends up to a magnification of about 1.0 or life-size. Macro takes over from there and gives larger-than-life images on the negative.

Close-Up Lenses—Clear-glass accessory lenses used to increase magnification look like filters and attach



This attractive bug was photographed with a 50mm lens at maximum magnification —as close as the lens would focus—which is about 0.11. Not enough, obviously. Entire frame is not reproduced here.



A simple and handy way to get more magnification is use of close-up lens attachments.

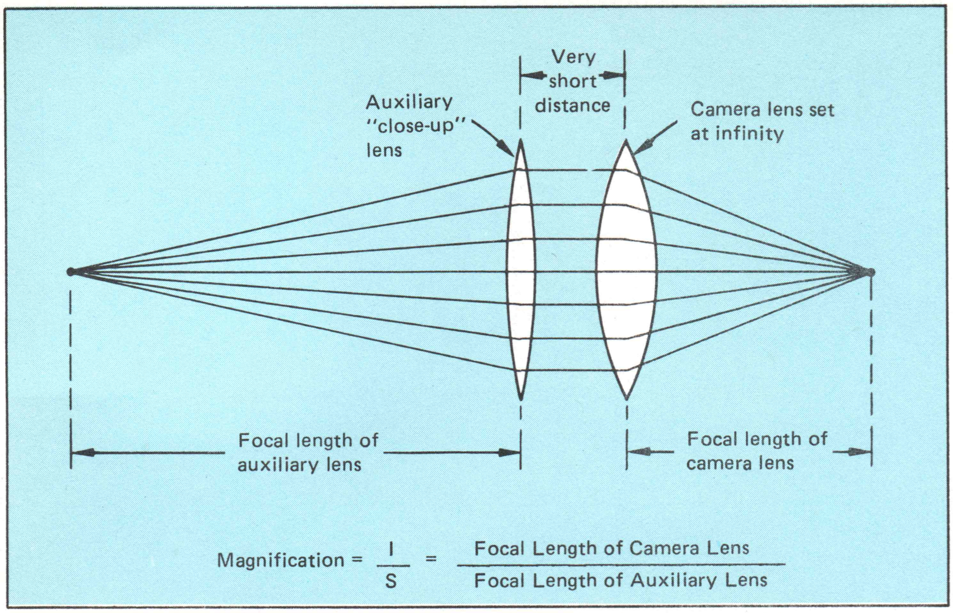
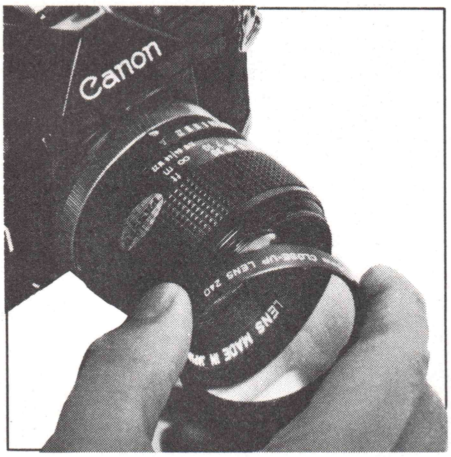

Very short distance
Auxiliary "close-up" lens
Camera lens set at infinity
Focal length of auxiliary lens
Focal length of camera lens
Magnification = I/S = Focal Length of Camera Lens / Focal Length of Auxiliary Lens

Figure 13-1/With auxiliary close-up lenses, magnification is easy to calculate.



Close-up lenses screw into the filter threads on the front of a camera lens. They should be kept clean and treated with the same care as other lenses.

the same way. They are called *supplementary* lenses, *close-up* lenses and sometimes *portrait attachments.* Canon refers to them as close-up lenses.

They work by playing a little optical trick on the camera lens, Figure 13-1.

If the camera lens is focused at infinity, so it is "expecting" parallel rays from the scene, it will bring them to focus at its own focal length.

With the close-up lens attached, the subject is placed in front of the lens at a distance equal to the focal length of the close-up lens. Light rays from every point of the subject enter the close-up lens and emerge as parallel rays which immediately enter the camera lens and are brought to focus on the film.

In this situation, magnification is easy to figure because the image distance is the focal length of the camera lens and subject distance is the focal length of the close-up lens. When these distances are known, magnification is simply I/S—Image distance divided by Subject distance. This formula and its application are in Figure 13-1.

Accessory close-up lenses are available at most camera shops in diameters to fit the filter threads of common lenses. If your lens uses filters with a 55mm thread diameter, get close-up lenses with the same thread diameter. Accessory close-up lenses often come in sets of three, identified as **1**, **2** and **3**. Some makers offer a **10** lens also. The focal length of the lens is concealed in its identification number.

These numbers are properly called *diopters,* a measure of lens *power.* Eyeglass prescriptions are written in diopters. The diopter rating of a lens is the reciprocal of its focal length—when focal length is *expressed in meters* rather than millimeters or any other unit. To find the diopter rating of a 500mm lens:

$$\frac{1}{0.5 \text{ meters}} = 2 \text{ diopters.}$$

That's a **2** close-up lens.

To figure magnification with one of these lenses, you need to work that problem backwards because you already know the diopter rating—it's marked on the lens. Focal length in meters is the reciprocal of the diopter rating.

$$\frac{1}{2 \text{ diopters}} = 0.5 \text{ meter or 500mm.}$$

If you are using a **2** close-up lens with a 50mm camera lens set at infinity, magnification is 50/500 = 0.1. *Only when the camera is focused at infinity.*

Focus the camera lens closer and two things happen. Image distance gets longer because the focusing mount moves the lens farther from the film. Subject distance gets shorter.

Therefore when you focus the camera lens closer than infinity with a close-up lens attached, magnification increases. Greatest magnification occurs with the camera lens focused at its shortest distance, but it isn't simple to calculate.

Figure 13-2 does the arithmetic for you. Based on a camera lens with focal length of 50mm, it gives minimum and maximum distances at which the subject can be focused, and it gives the range of magnifications obtainable over the focusing range of the lens. The numbers are approximate. This table covers all possible combinations of the standard set of three accessory lenses, and also a **10** lens.

Here's how to use the table. First, figure the amount of magnification you need. You can compare the height of a 35mm frame with the height of your subject, or compare widths. The height is 24mm, a little less than one inch. For most purposes assume it is an inch.

Figure 13-2
MAGNIFICATION WITH ACCESSORY CLOSE-UP LENSES

Camera Lens	Close-Up Lens	Maximum Subject Distance		Minimum Subject Distance		Magnification	
		MM	IN	MM	IN	MIN	MAX
50mm	1	1000	40	333	13	0.05	0.17
	2	500	20	250	10	0.10	0.22
	3	333	13	200	7.9	0.15	0.28
	3+1	250	10	167	6.2	0.20	0.33
	3+2	200	7.9	143	5.6	0.25	0.39
	3+2+1	167	6.2	125	4.9	0.30	0.45
	10	100	3.9	83	3.3	0.5	0.67

Figure 13-2/Approximate range of magnifications with commonly-available accessory close-up lenses used with a 50mm camera lens. For each case, maximum magnification occurs at minimum subject distance.

Figure 13-3
MAGNIFICATION WITH CANON CLOSE-UP LENSES

Camera Lens	Close-Up Lens	Maximum Subject Distance		Minimum Subject Distance		Magnification	
		MM	IN	MM	IN	MIN	MAX
50mm	450	450	18	237	9.3	0.11	0.23
	240	240	9.5	162	6.4	0.21	0.34
	450+240	156	6.1	118	4.6	0.32	0.47
100mm	450	450	18	300	12	0.22	0.37
	240	240	9.5	189	7.5	0.41	0.60
	450+240	156	6.1	133	5.3	0.64	0.84
200mm	450	450	18	379	15	0.44	0.57
	240	240	9.5	218	8.6	0.83	1.0
	450+240	156	6.1	146	5.8	1.3	1.5

Figure 13-3/Approximate magnification range of Canon close-up lenses used with 50mm, 100mm and 200mm camera lenses.

Canon
55mm
CLOSE-UP LENS
450
Canon
55mm
CLOSE-UP LENS
240

Canon offers sets of two close-up lenses which give the same range of magnifications as a set of three ordinary accessory lenses

If the subject is 3 inches tall and you want it to fill the frame vertically, you want a magnification of approximately 1/3, or 0.33. The table shows a magnification range of 0.20 to 0.33 if you stack a **3** with a **1** lens—a total of 4 diopters. With this combination, you will get the desired magnification with the camera lens focused at its closest distance. If you have the camera on a copy stand or tripod, you can set it so the front of the lens is about 6 inches from the subject and then find focus by looking.

This table is for a 50mm lens. If you use a 100mm lens, all magnifications in the minimum magnification column will double. Maximum values will not double, for a complicated reason.

Please notice the amount of overlap between the numbered close-up lenses. For example, a **1** has magnifications from 0.05 to 0.17. The **2** "backs up" and starts at 0.10, with a maximum magnification of 0.22. A **3** starts at 0.15, and so forth.

Canon Close-Up Lenses—Canon offers two close-up lenses identified as **450** and **240**. These numbers are the focal lengths of the lenses, *not diopters.*

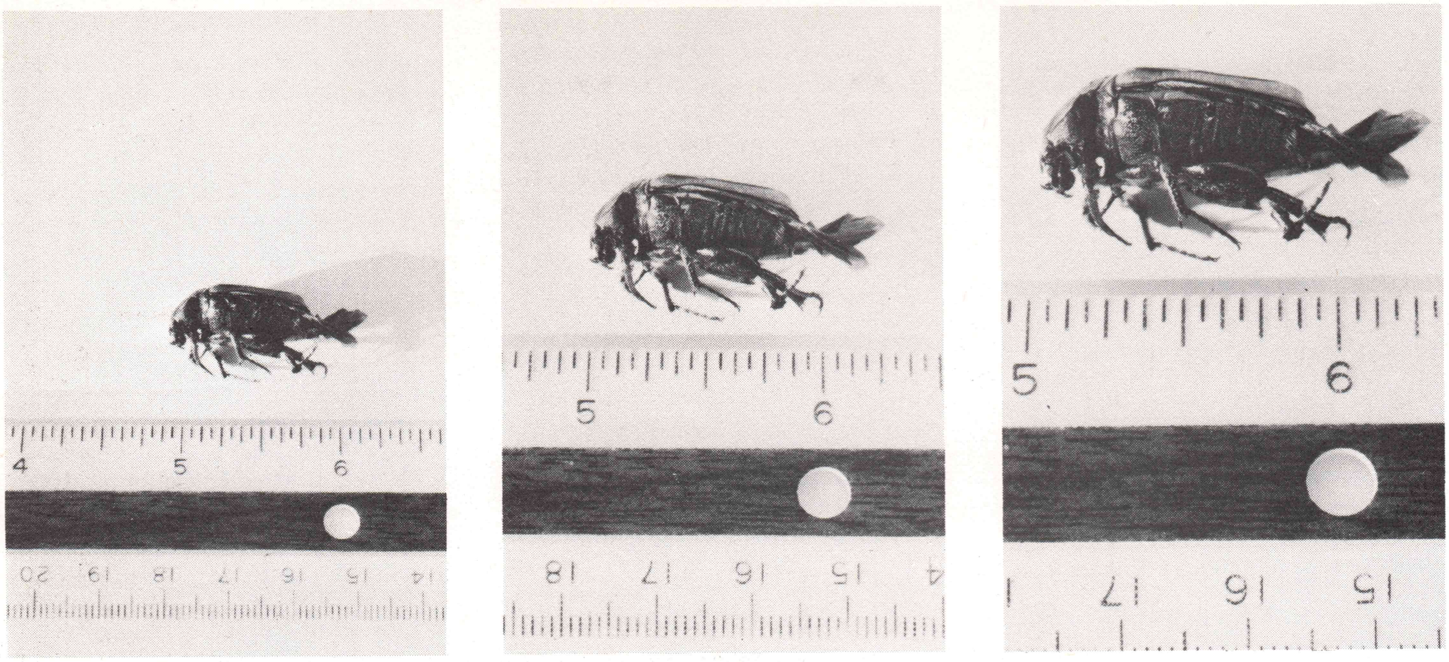
Figure 13-3 shows what these two close-up lenses will do individually and in combination. Notice the overlaps of magnification when used with a 50mm lens. The **450** goes from 0.11 to 0.23. The **240** only backs up to 0.21 and goes to 0.34. The two in combination start at 0.32 and go to 0.47.

With only two Canon close-up lenses, you can get every magnification possible with three accessory lenses: **1**, **2** and **3**. Until I did the arithmetic, I thought it was odd to offer **450** and **240** close-up lenses.

Canon recommends use of close-up attachments only with lenses from 35mm to 135mm because image quality will deteriorate with longer and shorter lenses. Most people say using close-up lenses for magnifications higher than about 0.5 causes noticeable reduction in image quality and recommend extension tubes instead—discussed in the following section.

However, you are the judge of image quality for your purpose and there is no harm in trying other combinations. Figure 13-3 shows magnifications for 50mm, 100mm and 200mm lenses. I have found a 200mm lens useful with close-up attachments and you may also if you don't expect too much.

The loss of image quality when using close-up lenses at higher

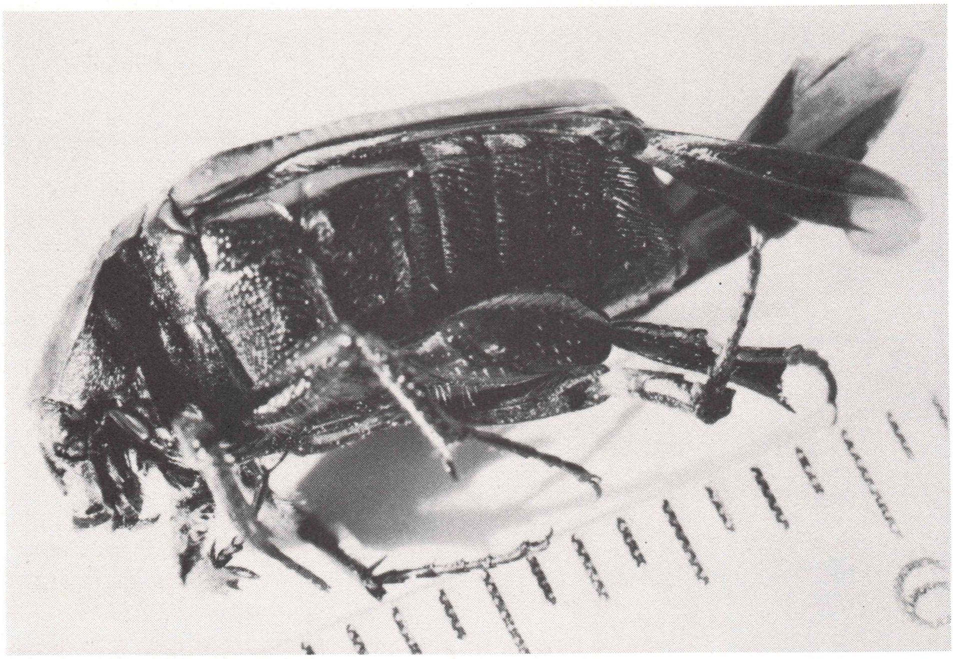


Same insect as before, photographed with 50mm camera lens using Close-up Lens 450 (left), Close-up Lens 240 (center), and both lenses stacked.

magnifications is a lack of sharpness and other symptoms of lens aberrations. This deterioration has two causes. One is the close-up lens itself. These are often single pieces of glass and, therefore, *uncorrected* lenses. To correct a lens for aberrations requires at least two pieces of glass of different optical properties. If there are only two glass elements, it's called a *doublet* lens.

The other cause is the fact that a close-up lens is added on. The camera lens used alone will make a very good picture because all of the glass elements work together to form an image and correct aberrations. When an accessory piece of glass is put in the same optical path, the lens corrections don't work as well because they were not calculated for a close-up attachment hanging out in front.

Canon offers close-up attachments in three diameters: 48, 55 and 58mm. However, the 55mm close-up lenses are most likely to be used because in every focal length from 28mm to 200mm



When using close-up lenses, magnification increases in direct proportion to focal length of the camera lens. Here a Canon 200mm *f*-4 lens was used with the Close-up 240 lens to get a magnification of about 0.8 on the negative—enlarged more to make this print. Depth of field is reduced at higher magnifications. Notice legs nearest camera.

there is at least one Canon lens which has a 55mm filter-thread diameter. Because the 55mm **450** and **240** close-up lenses are the ones you are most likely to use, Canon manufactures them as doublets with some correction of aberrations. They cost about twice as much as the 48mm and 58mm close-up lenses, which are singlets.

If you want the best image with close-up lenses, use the 55mm Canon doublets.

USING CLOSE-UP LENSES

As with any other high-magnification photography, the camera should be on a tripod or solid mount. If you are a solid mount, you can try hand-holding. Use a lens hood to exclude stray light from the surface of the lens.

These lenses are normally screw-in type with the thread pattern repeated on the outside of each lens to allow stacking. *Put the highest diopter lens nearest the camera.*

If possible, lock the mirror up to reduce vibration. These lenses do not interfere with camera automation, so you can meter and set exposure as you normally do. With semi-spot metering in the FTb and F-1 cameras, pay attention to what part of the subject you are metering on. Don't hesitate to use an 18% gray card for substitute metering.

Depth of field is usually a major problem in close-up and macro photography because it is seldom enough. About the only thing you can do is close down the lens. In the high-magnification domain, closing aperture is not as effective as in normal photography, but it will help some.

You may end up looking for more light and shooting at long exposure times so you can use a small aperture.

As a rule of thumb, doubling camera-lens focal length doubles magnification. Don't use two or three close-up lenses stacked if you can avoid it because every surface reflects light. I think it's better to use only one close-up lens with longer camera lenses to get more magnification.

Changing focus with any lens changes magnification, but when subject distance and image distance are about the same, focusing the lens causes large magnification changes. When you are trying to control image size in the frame and also find focus, it can be frustrating. A technique you will quickly discover is to set the focus control for magnification, then move the entire camera back and forth to find focus.

A good way to get acquainted with a new set of close-up lenses is to try different combinations while focusing on a yardstick.

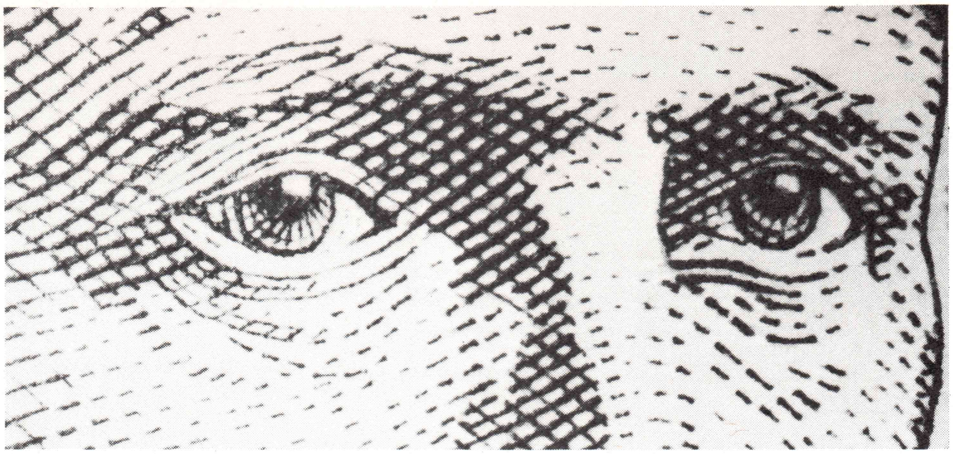
MACROPHOTOGRAPHY

Another way to increase magnification of a lens without adding any additional lenses in the optical path, is to locate the lens farther from the film. This increases image distance and therefore increases magnification.

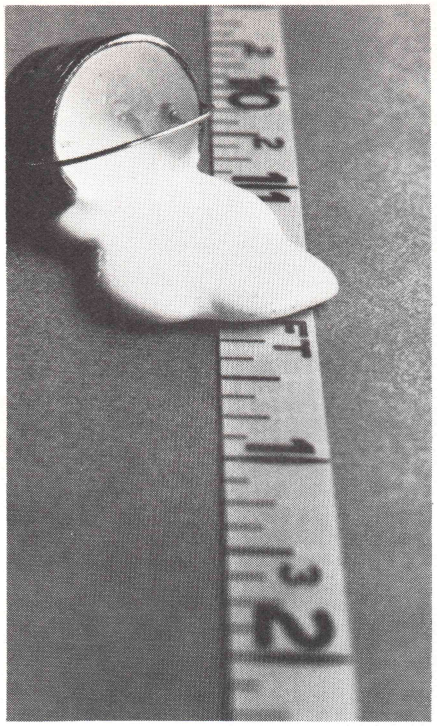
This can be done by *spacer rings* inserted between lens and camera body; also called *extension rings* and *extension tubes.* It can also be done by a bellows between lens and camera body, which has the advantage of continuous lens positioning at any distance between the maximum and minimum extension or *draw* of the bellows.

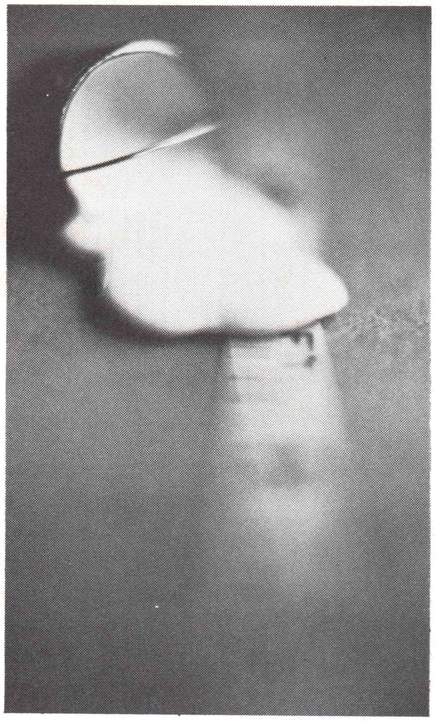
Magnification obtained by increasing the distance between lens and camera is calculated approximately by the formula $M = X/F$ where M is magnification, X is the *added* distance or extension of the lens, and F is the focal length of the

Photographed with 200mm camera lens and a 3 diopter accessory close-up lens, using flash. This is a good combination for stalking insects because you can take the picture with the front of the lens about 8 to 12 inches away. Flash stops motion. Magnification on the slide is about 0.7.



Detail of postage stamp shot using extension tubes at a magnification of about 5. Lens correction for flatness of field is very important in this type of photography.





Toy paint bucket tragedy photographed with 50mm camera lens and Canon 240 close-up lens. Top photo with lens at minimum aperture for best depth of field —perhaps 1.5 inches. Bottom photo with lens wide open. Depth of field is best seen by texture of background. At higher magnifications, using smaller aperture won't help this much.

lens being used. When X and F are equal, magnification is 1.0, as would be the case with a 50mm lens and 50mm of added extension *with the lens set at infinity.*

From the amount of magnification calculated as above, magnification can be increased by focusing the lens to shorter distances because that decreases subject distance and simultaneously adds image distance.

The same formula can be rearranged to figure the lens extension needed for a desired amount of magnification: X = F x M, where the symbols mean the same as before. Suppose you are using a 50mm lens and need a magnification of 0.8:

50mm x 0.8 = 40mm

This 40mm is added extension.

Using bellows or extension tubes, move the lens that far from its normal position and the magnification will be approximately 0.8 with the lens set at infinity.

Canon Extension Tubes—There are three types of extension tubes which fit between lens and camera body. The Extension Tube M set has breech-lock fittings which fit the camera mount at one end and the lens mount at the other. These are handy because they match the existing camera and lens mounts, but the size range is limited.

Extension Tube M set consists of four tubes.

One 5mm tube
One 10mm tube
Two 20mm tubes

The shortest extension is with the 5mm tube between camera and lens. With a 50mm lens, the magnification is 5/50 = 0.1 which means that extension tubes also start where the normal lens stops and go to higher magnifications from there. You can get any magnification with lens extensions that you can get with close-up lenses. But with lens extensions you can go a lot higher—into the macro range—with less image degradation.

All of the tubes in the M set connected together add up to 55mm. With a 50mm lens, it gives a magnification of about 1.1—slightly more than life size.

You can use extension tubes with lenses of any focal length but magnification obviously increases with shorter lenses.

Another set of extension tubes was originally designed for Canon rangefinder cameras with screw-type lens mounts. These have male threads at one end and female on the other for connecting end-to-end. The series is:

Tube A—6mm
Tube B—9mm
Tube C-12mm

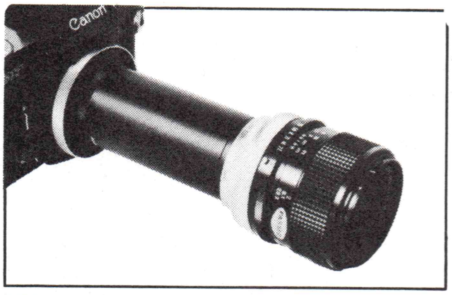
Plus numbered extension tubes identified with numbers equaling length in millimeters: 25, 50, 75, 100, 150, and 200.

M 20
M 20
M 10
M 5
Canon
Canon Japan

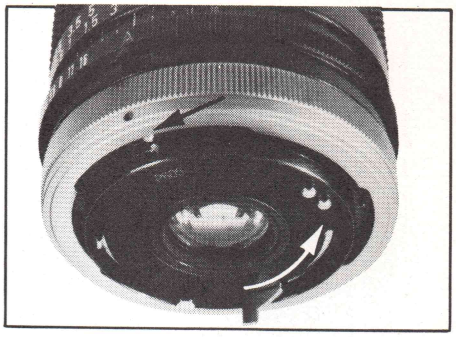
Extension Tube M set uses standard Canon breech-lock mounts to fit camera on one side and lens on the other. These can be stacked for more extension. Nomenclature is engraved on the items.

Canon EXTENSION TUBE 100mm

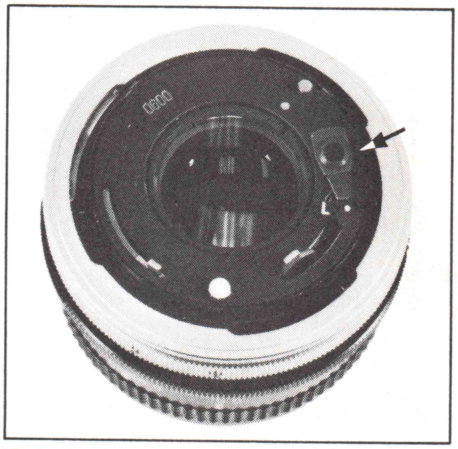
For longer extensions, use screw-type tubes available in lengths from 6mm to 200mm. Tubes screw together as desired, require Lens Mount Converters A and B to adapt the threaded ends to Canon mounts.



100mm screw-type extension tube with Lens Mount Converter A at camera end, converter B at lens. With 50mm lens, this gives magnification of 2. For best picture quality, lens should be reversed.



When lens is mounted backwards, these pins and levers become the "front" of the lens. Aperture control is manual. To set lens for manual control of aperture, do two things: Move Automatic Aperture (white arrow) lever counterclockwise to the end of its slot. Rotate the knurled Breech-Lock Ring as though the lens was being mounted on the camera which unlocks the internal mechanism of the lens. If lens is equipped with a Mount Lock Pin (black arrow) it must be depressed to rotate Breech-Lock Ring.



If the back of your lens looks like this, set it for manual aperture control using the lever lock.

Screw-type extension tubes require adapters on both ends to fit breech-lock mounts on Canon SLR lenses and camera bodies. Lens Mount Converter A fits on the camera body and accepts the screw-in extension tubes, or even a screw-mount lens from the rangefinder camera lens assortment. This converter itself adds 2.8mm of extension.

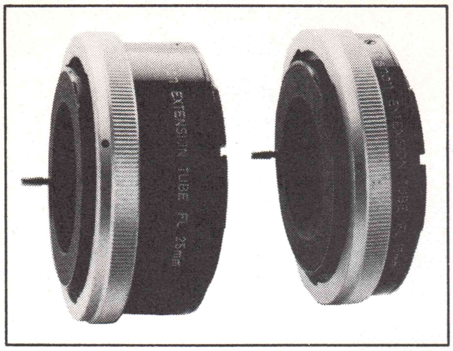
At the front end of screw-type extension tubes, use Lens Mount Converter B to accept Canon FD and FL-type lenses. This converter adds 13.2mm of extension to the end of the tube. Thus Lens Mount Converters A and B together add 16mm to the extension total, in addition to whatever the tubes themselves contribute. Take this into account when figuring magnification.

There is no theoretical limit to the amount of extension you can use. If one each of the screw-type extensions together with adapters A and B were all connected together, the total extension would be 643mm. With a 50mm lens this gives a 12.8 magnification! Canon recommends using extension tubes up to magnifications of 8 or less. If you need more than 8, shoot through a microscope.

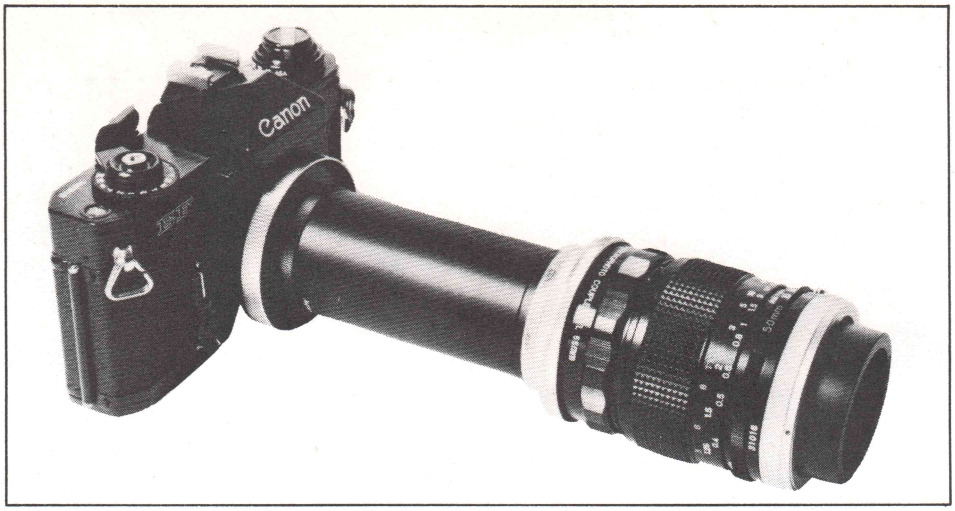
None of the extension tubes discussed so far provide for meter coupling between lens and camera or for automatic aperture control. You operate the aperture manually by rotating the aperture ring on the lens. To set up FL or FD lenses for manual operation of the aperture, move the Automatic Aperture lever on the back of the lens to the Manual setting (counter-clockwise movement) and lock it in position on lenses so equipped. Other lenses will lock automatically. Do this before mounting the lens on the extension tube.

Because these extension tubes do not couple a full-aperture signal back to the camera, you cannot use full-aperture metering, even with an FD lens. Therefore you meter stopped-down. You can view and focus at full aperture, by manually opening the lens. Then manually set the lens to the aperture for shooting and balance the exposure controls in the viewfinder while holding or locking the Stopped-Down lever toward the lens.

Yet another series of extension tubes, identified as the FL type come in two lengths: FL15 and FL25—the number is the length in millimeters. These were designed for use with FL lenses which have full-aperture viewing but not full-aperture metering. Metering is done stopped-down.



Extension Tube FL25 and FL15 preserve automatic aperture operation—the camera stops down the lens at the moment of exposure. The movable pins on the extension tubes transmit the mechanical movement from camera to lens. Using these stacked together to get 40mm of extension is not recommended because of added friction and play in the linkage.



From left to right: EF camera, Lens Mount Converter A, 100mm extension tube, Lens Mount Converter B, Macrophoto Coupler FL, Canon 50mm Macro lens reversed, MacroHood. This will give magnification in the range of 3.5 to 3.8. You can't hand-hold this combination. Mount it on a tripod or copy stand.

FL extension tubes are equipped with breech-lock fittings and require no lens-mount converters. They are slightly more convenient to use than the M series because the camera stops down the lens to shooting aperture so you don't have to do it manually.

Macrophoto Coupler – Photographers sometimes argue that extension tubes cannot possibly affect image quality because only air is added in the optical path. A mighty blow to this errant logic is the reminder that when a lens is out of focus, the only thing wrong is too much or too little air between lens and film.

Even when properly focused, the argument ignores the fact that most lenses—except special Macro lenses—are designed and optically corrected for subject distances considerably longer than image distances. As these distances become more nearly equal due to extension tubes and close focusing on the subject, lens corrections don't work as well. Picture quality is reduced.

At magnifications greater than 1.0, image quality is improved by reversing the lens so the longer "throw" is on the same side as the designer intended—even though it becomes image distance rather than subject distance.

Hardware to attach a lens backwards is commonly called a *reversing ring,* but Canon calls it a *Macrophoto Coupler.* There are two types, each in three thread diameters—48mm, 55mm and 58mm. When using these couplers, you must operate the lens manually and meter stopped-down.

Macrophoto Coupler 48, 55, or 58 is a simple reversing attachment. It is used with Lens Mount Converter A between coupler and camera body, or coupler and bellows, or coupler and extension tubes.

Macrophoto Coupler FL helps overcome the occasional problem resulting from extension tubes with fixed lengths. It accepts lenses mounted backwards and provides variable lens extension up to 13mm with a built-in helicoid focusing mechanism.

In addition to the variable extension the FL coupler has a fixed extension depending on coupler diameter as follows:

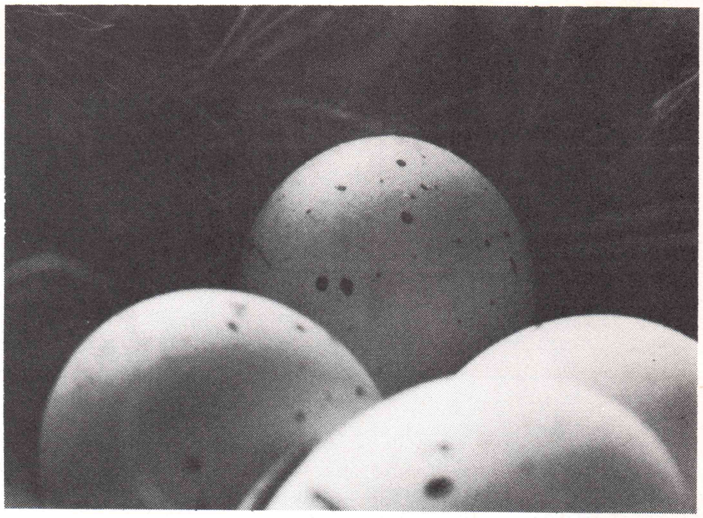
Macrophoto Coupler	Fixed Extension	Variable Extension
FL48	24mm	0-13 mm
FL55	20mm	0-13 mm
FL58	20mm	0-13 mm

Both Macrophoto Couplers have threads on the forward side to match filter-ring threads on the lens. The FL coupler breech-lock fitting fits any suitable extension tube or mount converter, and also fits the lens mount on the camera body. It can be used without any other extension between camera and a reversed 50mm lens to give magnifications from about 0.5 to 0.75.

Although any lens can be reversed, for serious photography and the best possible image, Canon recommends use of a macro lens specially designed for macrophotography.

Canon's special 50mm *f*-3.5 S.S.C. Macro lens comes with one extension tube called a *Life-Size Adapter* to increase magnification to life size. This lens with the Life-Size Adapter and a Macrophoto Coupler FL is a handy set for close-up nature photography. The combinations give a range of magnifications as follows:

The 50mm Macro lens alone gives magnifications up to 0.5 because the focusing control has a longer range of movement than normal lenses. The shortest focusing distance from the front of the lens is about 6 inches, compared to 18 inches for a normal 50mm lens, therefore it gives higher magnification with no additional accessories.



Canon 50mm Macro lens with Life-Size Adapter—actually a 25mm extension—gives magnifications from 0.5 up to 1 and is handy for stalking nature.

With the Life-Size Adapter, magnification ranges from 0.5 to 1.0.

Early 50mm Macro lenses, used with the extender, required metering stopped down. Current production lenses and FD 25 Extension Tubes are meter-coupled so you can meter at full aperture.

Reversing the Macro lens and using the Macrophoto Coupler FL to fit on the camera allows magnification from 1.2 to 1.4.

As a sharp-eyed reader you noticed that the FL55 coupler only provides 20mm of fixed extension plus another 13mm of variable extension. That doesn't sound like enough to get a 50mm lens above life-size magnifications. It isn't with extension rings mounted on the back of the lens. When the lens is reversed, the distance between the filter mounting ring where the Macrophoto coupler is attached and the lens itself is additional extension. This distance is 41.2mm. In other words, just reversing the Macro lens adds an additional 41.2mm to the extension of the lens. This should be added to any other extension being used, to figure magnification.

A recent addition to the Canon line is the FD 100mm *f*-4 S.C. Macro Lens. In general, it is similar to the 50mm macro. It gives magnifications up to 0.5 with no accessories. A special extension comes with this lens—Extension Tube FD 50—which gives magnifications from 0.5 to life size. This extension tube does what the FD nomenclature implies. It preserves all features of an FD lens, as long as it isn't reversed. With Extension Tube FD 50 installed between camera and the FD 100mm Macro lens, you meter wide open.

MacroHood—A reversed lens still benefits from a hood to shield the surface from stray light, but your standard sunshade won't fit. The MacroHood fits on the back side of the lens.

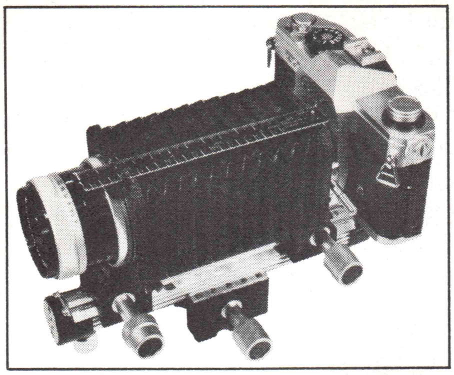
Macrophoto Coupler FL has a built-in helicoid which moves the camera lens over a 13mm range, independent of the helicoid in the camera lens. When used with a reversed 50mm Macro lens the combination gives magnifications from 1.2 to 1.4.

With the lens reversed, you have to use stopped-down metering and control aperture by rotating the aperture ring on the lens. You should remember to move the Automatic/Manual Aperture Lever on the back of the lens to the counterclockwise position to set it for manual control of aperture.

Some Canon lenses of recent manufacture have a Mount Lock Pin under the edge of the Breech-Lock Ring which locks the ring as the lens is removed from the camera. With the ring locked in the *open* position, the lens controls don't work and you can't set aperture manually.

Attaching the MacroHood automatically depresses the lock pin as you rotate the Breech-Lock Ring to clamp the MacroHood in place. This automatically makes the lens operable manually. If you don't have a MacroHood, depress the Mount Lock Pin with a small tool or screwdriver and rotate the Breech-Lock Ring as though you were mounting the lens. This unlocks the lens mechanism and you can set aperture manually.

If you buy an FL Macrophoto



Bellows FL has three adjusting knobs. Adjuster at front moves lens independent of camera. Adjuster at rear moves camera independent of lens. Adjuster in middle moves camera and lens together, toward or away from subject which changes focus without affecting magnification. On the opposite end of each adjuster is a lock knob. Scale reads extension and magnification for a 50mm lens. Lens is special FLM 100mm for use on bellows.

Coupler, a MacroHood is included in the package.

BELLOWS

Two types of bellows are available: M and FL. Both use breech-lock mounts at both ends and fit between lens and camera. The theory of extension by bellows is the same as by fixed tubes.

Bellows M has no automatic features. It accepts lenses directly or reversed with either of the Macrophoto Couplers. A rack-and-pinion gear extends the bellows from 33mm to 145mm. Read the extension directly from a scale on the extension rod below the bellows.

Bellows M has a tripod socket on the bellows and the combined camera with bellows balances better on a tripod or copy stand if the bellows socket is used instead of the camera socket. This bellows has only one adjusting screw to move the lens in relation to the camera.

Bellows FL allows automatic aperture operation by the stopped-down lever on the camera and also during shooting. Both bellows require stopped-down metering.

Bellows FL adjusts from 34.5mm to 142.5mm extension.

The bellows scale reads extension distance and reproduction ratio or magnification. Automatic-aperture control is accomplished by rods which run the length of the bellows. A lever on the side should be depressed before mounting FL or FD lenses to couple the aperture-control system to the aperture lever on the back of the lens. The lens should be set for automatic operation of the aperture.

A special bracing strut extending from the front of the FL bellows can be used as a steady-rest when pointing downward by extending the strut until it contacts the table top or copy-stand base and locking the strut in that position.

LIGHT PROBLEMS WITH LENS EXTENSION

From the film's point of view, light comes from the back end of the lens as an expanding cone making a circle at the film plane.

Light sources which produce diverging rays are subject to the *inverse-square law.* The law says the amount of light changes inversely with the distance from the light source. The farther away from the source, the dimmer the light is.

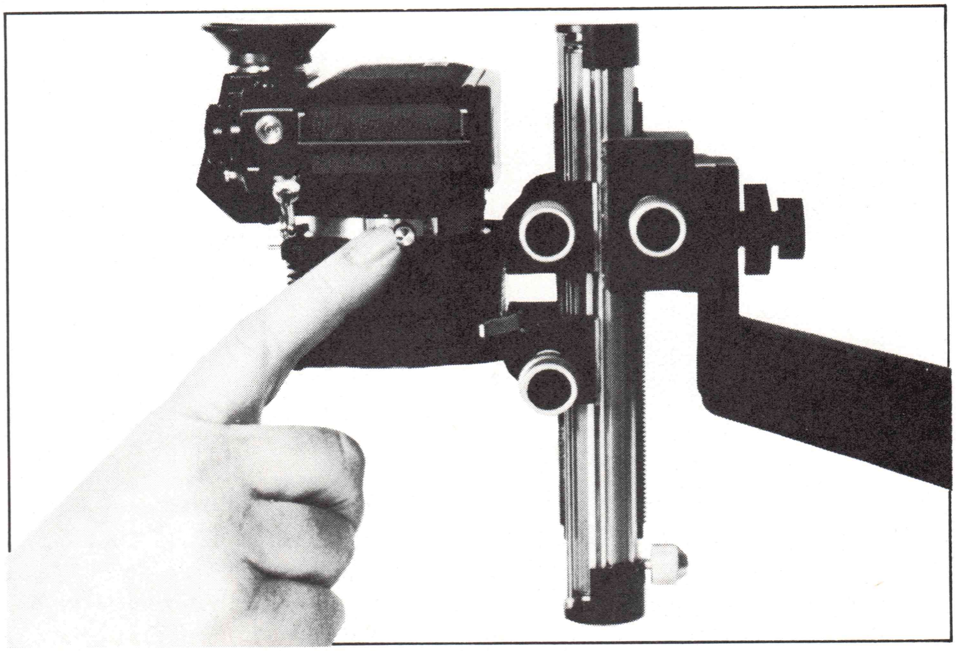
Between the infinity setting and full extension of a *normal* lens, the amount of light changes by about 20%. If you set exposure controls after focusing, it doesn't matter because you set exposure for whatever light there is. If you ignore the light change by setting exposure and then focusing, it still doesn't matter very much, because 20% is not of major significance and will usually not be noticeable on the film.

When you use extension rings or a bellows to put extra distance between lens and film, the effect is noticeable.

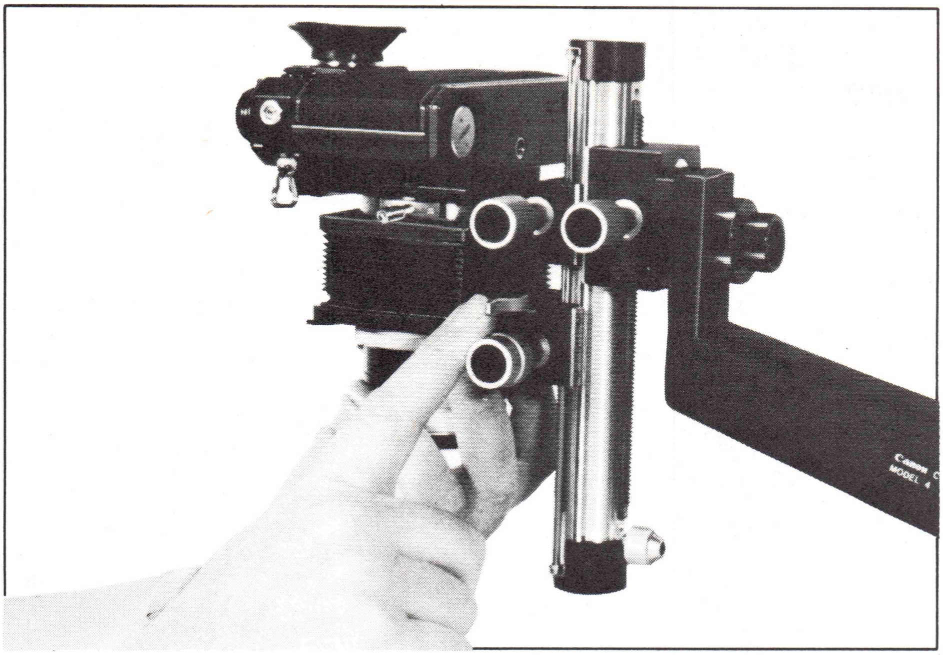
The light loss due to adding lens extension is seen by the metering in the camera, so correction is automatic so long as you set exposure controls *after* you set lens extension. There can be cases where the light is so low that the camera exposure meter doesn't give any reading. The Canon Booster or Booster T Finder may solve the problem if you have either one.

If all else fails, you meter the subject as though you were going to shoot it without any extra lens extension, then calculate the loss of light due to the lens extension you plan to use, then correct the exposure settings to compensate for the light loss.

There are several ways to meter the subject without lens extension. You can remove the extension



Back side of bellows has breech-lock mount similar to back of lens. Extended handle makes it easy to rotate mount to attach camera.



Front of bellows mounts lenses in the normal way. Before attaching a lens, depress lever as shown to allow mechanical coupling of automatic aperture-control lever.

tubes or bellows from your camera, meter the subject, then reinstall the extension devices. If you have two cameras, you can use one without extension to meter the subject. Or you can use a separate accessory-type exposure meter.

There are two types of accessory exposure meters. A *reflection-type* meter measures light reflected from the subject. An *incident* meter measures light falling on the subject. For macrophotography, Canon recommends an incident meter. Some meters can be used both ways—consider this if you're going to buy one.

To calculate approximately the light loss due to extension, use this formula:

$$\text{Exposure Correction Factor} = (1 + M)^2$$

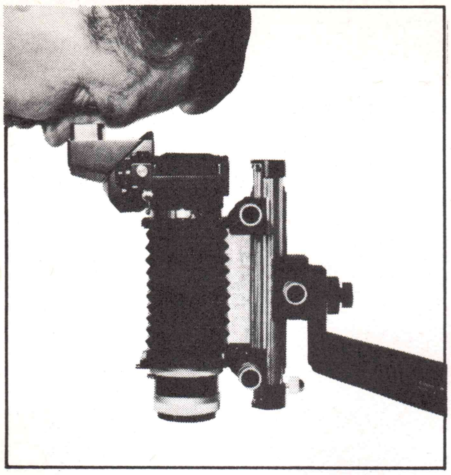
where M is the magnification you will get from the extra extension.

Suppose your equipment is set up to give a magnification of 2. The correction factor is $(1 + 2)^2 = 9$. If

EXPOSURE CORRECTION FACTORS FOR 50MM LENS

Magnification	Exposure Factor	Aperture Adjustment (*f*-stop)	Magnification	Exposure Factor	Aperture Adjustment (*f*-stop)	Magnification	Exposure Factor	Aperture Adjustment (*f*-stop)
0.1	1.21	0.28	3.2	17.64	4.14	6.8	60.84	5.93
0.2	1.44	0.53	3.4	19.36	4.28	7.0	64.00	6.00
0.3	1.69	0.76	3.5	20.25	4.34	7.2	67.24	6.07
0.4	1.96	0.97	3.6	21.16	4.40	7.4	70.56	6.14
0.5	2.25	1.17	3.8	23.04	4.53	7.5	72.25	6.18
0.6	2.56	1.36	4.0	25.00	4.64	7.6	73.96	6.21
0.7	2.89	1.53	4.2	27.04	4.76	7.8	77.44	6.28
0.8	3.24	1.70	4.4	29.16	4.87	8.0	81.00	6.34
0.9	3.61	1.85	4.5	30.25	4.92	8.2	84.64	6.40
1.0	4.00	2.00	4.6	31.36	4.97	8.4	88.36	6.47
1.22	4.84	2.27	4.8	33.64	5.07	8.5	90.25	6.50
1.4	5.76	2.53	5.0	36.00	5.17	8.6	92.16	6.53
1.5	6.25	2.64	5.2	38.44	5.27	8.8	96.04	6.59
1.6	6.76	2.76	5.4	40.96	5.37	9.0	100.00	6.64
1.8	7.84	2.97	5.5	42.25	5.40	9.2	104.04	6.70
2.0	9.00	3.17	5.6	43.56	5.45	9.4	108.16	6.76
2.2	10.24	3.36	5.8	46.24	5.53	9.5	110.25	6.78
2.4	11.56	3.53	6.0	49.00	5.62	9.6	112.36	6.81
2.5	12.25	3.63	6.2	51.84	5.70	9.8	116.64	6.87
2.6	12.96	3.70	6.4	54.76	5.78	10.0	121.00	6.92
2.8	14.44	3.85	6.5	56.25	5.81			
3.0	16.00	4.00	6.6	57.76	5.85			

Exposure Factor is $(1+M)^2$ where M is magnification. When you *don't* use meter in camera reading through extension devices, measure light and figure indicated exposure as though no extensions were to be used. Then correct exposure according to the magnification. To correct by changing shutter speed, multiply indicated speed by the Exposure Factor and take the nearest available setting. To correct by changing aperture, make aperture larger by indicated *f*-stop adjustment. You can make part of the correction in shutter speed and the rest in aperture if desired.



The Speed Finder is a very handy accessory for copy stand use.

you metered the subject directly rather than through the extension, you need about 9 times as much exposure. You get it by multiplying exposure time by 9, or by opening aperture to let 9 times as much light through—which is a little more than 3 stops—or any combination of the two.

The shutter speed you end up using may be in the range that indicates reciprocity failure. Check the film data sheet.

Whenever there is technical uncertainty including reciprocity failure, and when it is important that you get a good exposure, bracketing is a good idea.

The formula and example just given for exposure correction apply to lenses near 50mm focal length. Exposure correction for telephoto and retrofocus lenses mounted both normally and reversed is more complicated and there are several more formulas. If you are interested in this subject, I cover it thoroughly in *SLR Photographers Handbook*, also published by H.P.Books.

SPECIAL LENSES FOR MACROPHOTOGRAPHY

The FD 35-70mm and the FD 28-50mm Zoom lenses have a special "macro" setting which positions the lens elements for short subject distances. These lenses are not intended for table-top macrophotography such as copying or photographing flat subjects such as a stamp collection. They are not as fully corrected for flat subjects as the Canon Macro lenses.

The special focusing feature of these two zoom lenses should properly be called "close focusing" rather than "macro" because magnification is only about 0.2. It's handy to have this extra magnification when photographing nature.

The FD 50mm *f*-3.5 S.S.C. Macro lens is intended for general outdoor photography and also precision copying of flat subjects. It can be used on the camera, on extension tubes, or on a bellows.

The lens itself has an unusually long movement range with the focusing control—long enough so it will cause a noticeable reduction of light on the film. The light change is about a half-stop. You will see it in the viewfinder display and compensate for it when you set the exposure controls.

The 100mm macro lens has the same general application as the 50mm, with some important differences. When focusing at normal distances, rather than close-up, a 50mm macro lens has the same angle of view as any other 50mm lens, and a 100mm macro lens behaves the same as any other 100mm lens. When focusing close-up, the 100mm lens allows more distance between the front of the lens and the subject than a 50mm lens operating at the same magnification. The additional distance makes it easier to get light on the subject and, if you are photographing a wary insect, the greater shooting distance may persuade it to continue posing rather than fly or flee.

The FLM 100mm *f*-4 lens has no built-in focusing mechanism. It is intended for use on a bellows.

USING CLOSE-UP AND MACROPHOTO EQUIPMENT

Details of close-up lens use and magnification have already been covered. The lens-extension formula given earlier is a guide for lens-extension tubes and bellows extension.

Calculation is simple: If you need a magnification of 2.5 with a 50mm lens, the needed additional extension is 2.5 x 50 = 125mm. Then look through the camera to find focus and confirm magnification.

If you are using a tripod or copy stand to support the camera, it helps to make a rough set-up with approximately correct distances between lens and subject. This is easy if you remember: Magnification = Image distance divided by Subject distance, M = I/S. Therefore S = I/M.

In the case above, image distance is the lens extension *plus* the focal length of the lens—125mm + 50mm = 175mm. S = 175/2.5 = 70mm. Put the camera lens about 70mm from the subject and it won't be very far from focus.

In high-magnification photography, take all possible measures to guard against camera vibration. If possible, lock up the mirror after focusing and before shooting. Use a cable release or the self-timer on the camera to trip the shutter.

Depth of field is often a major problem except for flat subjects. To get reasonable depth of field requires shooting at small aperture, which in turn may complicate lighting for exposure. When the camera lens is close to the subject, it is sometimes difficult to get enough light. This is largely a matter of technique and the lighting equipment you have available.

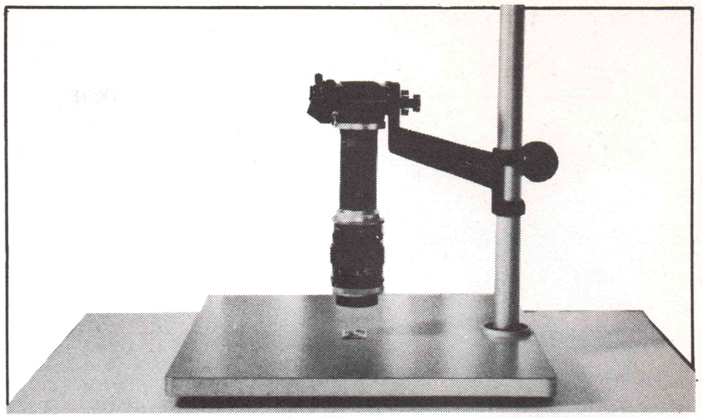
Often it is necessary to experiment with lighting to bring out the details you want to show, particularly with limited depth of field. Sometimes sidelighting gives good modeling and puts shadows where the depth of field is poor anyway. When there is not enough depth of field to include all of the subject or surface variations you are photographing, it is usually best to put good focus near the front of the object and let it drift off into poor focus as it recedes into the fuzz.

When lenses are not reversed, you can use the lens-focusing mechanism to change magnification and focus. If the two are in conflict, use the focus control to set

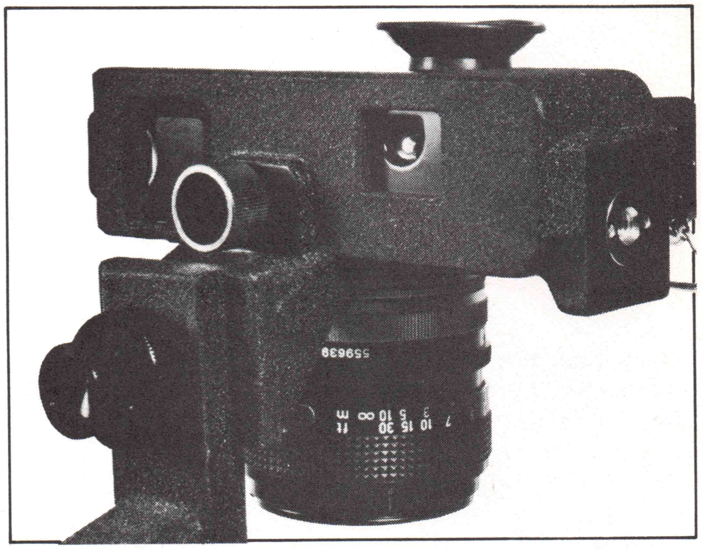
EXTENSION LENGTH OF ACCESSORIES

ITEM		EXTENSION (mm)
Bellows FL		34.5 to 142.5
Bellows M		33 to 145
Extension Tube M5		5
M10		10
M20		20
Macrophoto Coupler FL55, FL58		20 to 33
Lens Mount Converter A		2.8
Lens Mount Converter B		13.2
Screw-type Extension Tube	6mm	6
	9mm	9
	12mm	12
	25mm	25
	50mm	50
	75mm	75
	100mm	100
	150mm	150
	170mm	170
	200mm	200
Extension Tube FL15		15
FL25		25
Life-Size Adapter–50mm Macro		25
Extension due to reversing 50mm Macro		41.2
Extension Tube FD50–100mm Macro		50
Extension due to reversing 100mm Macro		55.1

To figure magnification using lens extension, add up the extension provided by each accessory between lens and camera. Then use the formula $M = X \div F$, where M is magnification, X is total lens extension and F is focal length of lens being used.



You can use extension tubes on copy stand instead of bellows, with less flexibility in magnification range. This is Copy Stand 4.



Camera Holder F is useful to hold the camera on a tripod or copy stand. Particularly with long lenses or lens extension, it adds rigidity to the set up.

magnification and move the entire camera to find focus.

When lenses are reversed, the focus control doesn't have any effect. When the lens is *attached* by its front ring, the focus control moves the back mounting fixture in and out, but doesn't change the location of the lens itself.

When using 75mm or longer tube extensions on the camera, the Macrophoto Strut clamps onto the lower part of the extension tube to brace its rubber tip against the copy stand base to reduce vibration.

A convenient small copy stand for use on a desk or table with camera and extension tubes is the Handy Stand F. It is a four-legged "tripod" with marks on the legs so all can be extended the same amount to keep the camera parallel with the table top. It includes an F ring to fit the lens filter ring and thus support the camera, and one Extension Tube M5.

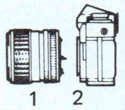
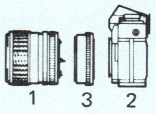
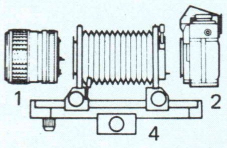
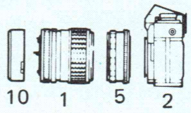
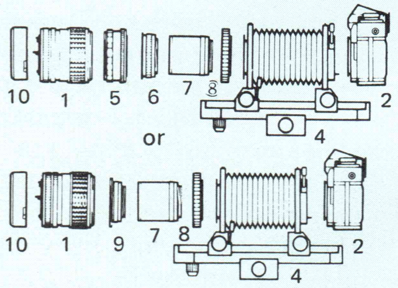
Viewing aids described earlier are useful on a copy stand to make viewing and composing easier. These include the Speed Finder and the Waist Level Finder for the F-1 and Angle Finders A_2 and B. Magnifier R with the normal Eye-level Finder helps get good focus under difficult circumstances when you don't have any excess depth of field anyway.

For the F-1, Focusing Screen D has ruled squares which help in copying.

The Booster T Finder for the F-1 and the Canon Booster for the FTb are of great value with long lens extensions when there isn't much light to work with.

Duplicating Slides—Bellows FL has provision to mount a slide holder on the end of the bellows track. The mounting screw attaches to the hole in the end of the track where the bracing strut pops out when

HOW TO INCREASE MAGNIFICATION BY LENS EXTENSION

Lens	Magnification	Distance between Subject and Film Plane (mm)	Lens Extension (mm)	Equipment Needed
50mm Macro	up to 0.5	∞ to 232	0 to 25	
50mm Macro with Life-Size Adapter	0.5 to 1	232 to 205	25 to 50	
50mm Macro with Bellows FL	0.67 to 2.76	263 to 214	35 to 143	
50mm Macro reversed with Macrophoto Coupler FL	1.2 to 1.4	212 to 207	61 to 74	
50mm Macro reversed on Bellows FL with added extension	2.3 to 8.4	541 to 238	118 to 433	 10 1 5 6 7 8 2 4 or 10 1 9 7 8 2 4

This table does not include all possible combinations. For example, extension tubes can be used in place of bellows.

Lenses with different focal lengths can be used in a similar way.

Longer focal lengths require proportionately more extension to give the same magnification. For example, a 100mm lens requires twice as much extension as a 50mm. Shorter focal lengths require proportionately less extension.

Longer focal lengths give more working distance between lens and subject which is often desirable for lighting the subject.

1 **Lens**
2 **Camera**
3 **Life-Size Adapter**
4 **Bellows FL**
5 **Macrophoto Coupler FL 55mm**
6 **Lens Mount Converter B**
7 **Extension Tube**
8 **Lens Mount Converter A**
9 **Macrophoto Coupler 55mm**
10 **Macrohood**

Handy Stand F is lightweight and useful for copying documents. Extension Tube M5 which is supplied with the stand allows a 50mm lens to focus at the table top.

you need to steady the bellows.

The slide holder has its own bellows to exclude light from the path between slide and lens. It allows the lens to move by changing the length of the Bellows FL, and therefore the magnification of the slide image can be changed on the film in the camera.

Cropping in the slide duplicator is aided because the slide can be shifted slightly sideways or up and down as much as desired.

Mounted slides can be inserted in the slide holder. Unmounted slides can also be duplicated by opening up the holder and placing the sprocket holes of the unmounted slide over pins inside the unit.

The slide should be inserted with the emulsion side toward the light—that is, away from the camera. Slides can be duplicated the other way around if you need to reverse the image left-to-right for some reason, so long as the camera is focused on the image in the emulsion.

On the back side of the slide, meaning the side away from the camera lens, is a frosted glass pane to give uniform illumination across the slide unless there is a very bright spot of light on the frosted glass.

Exposure can be read directly from the camera metering and it is normally possible to shoot at ordinary speeds such as between 1/30 and 1/500. You can do this simply by controlling the amount of light entering the slide holder through the frosted glass pane.

For the most realistic color rendition, the light used should agree with the film in the camera—daylight for daylight film, and so forth. It is possible to use filters over the lens to correct color quality of the light or for special effects.

Duplicating a slide onto slide film is a positive-to-positive process and the colors of the duplicate slide will not usually be exact duplicates of the original. This is often not noticed or the effect is small enough to be tolerated. Also, an increase in contrast is common when duplicating slide-to-slide.

If you just want one or a few copies of a slide and you don't need duplicates very often, you are probably better off having your duplicates made by a commercial laboratory. For best quality, you need an internegative made as an intermediate step leading to the final duplicate, which labs are set up to do.

Slide-duplicating equipment is a good purchase for the ordinary photographer only if he intends to make duplicates in volume, or create new images by sandwiching existing slides and duplicating the result and perhaps change colors by using filters during the duplicating process. If you know you will need several copies of a slide, expose more originals.

MICROPHOTOGRAPHY

This is photographing through a microscope to get magnifications larger than the 8 or 10 normally practical with extension tubes. Magnifications up to 2,000 are possible with the right microscope.

Because the microscope replaces the camera lens, there is no camera *f*-stop to be concerned with. Exposure is arrived at using whatever light comes into the camera and an appropriately long exposure time. This makes lighting of the subject critical and sometimes difficult. The technique of using microscopes and illuminating the subject is beyond the scope of this book, but can be found in books on microscopes.

Two accessories allow optically and mechanically connecting a camera to a microscope.

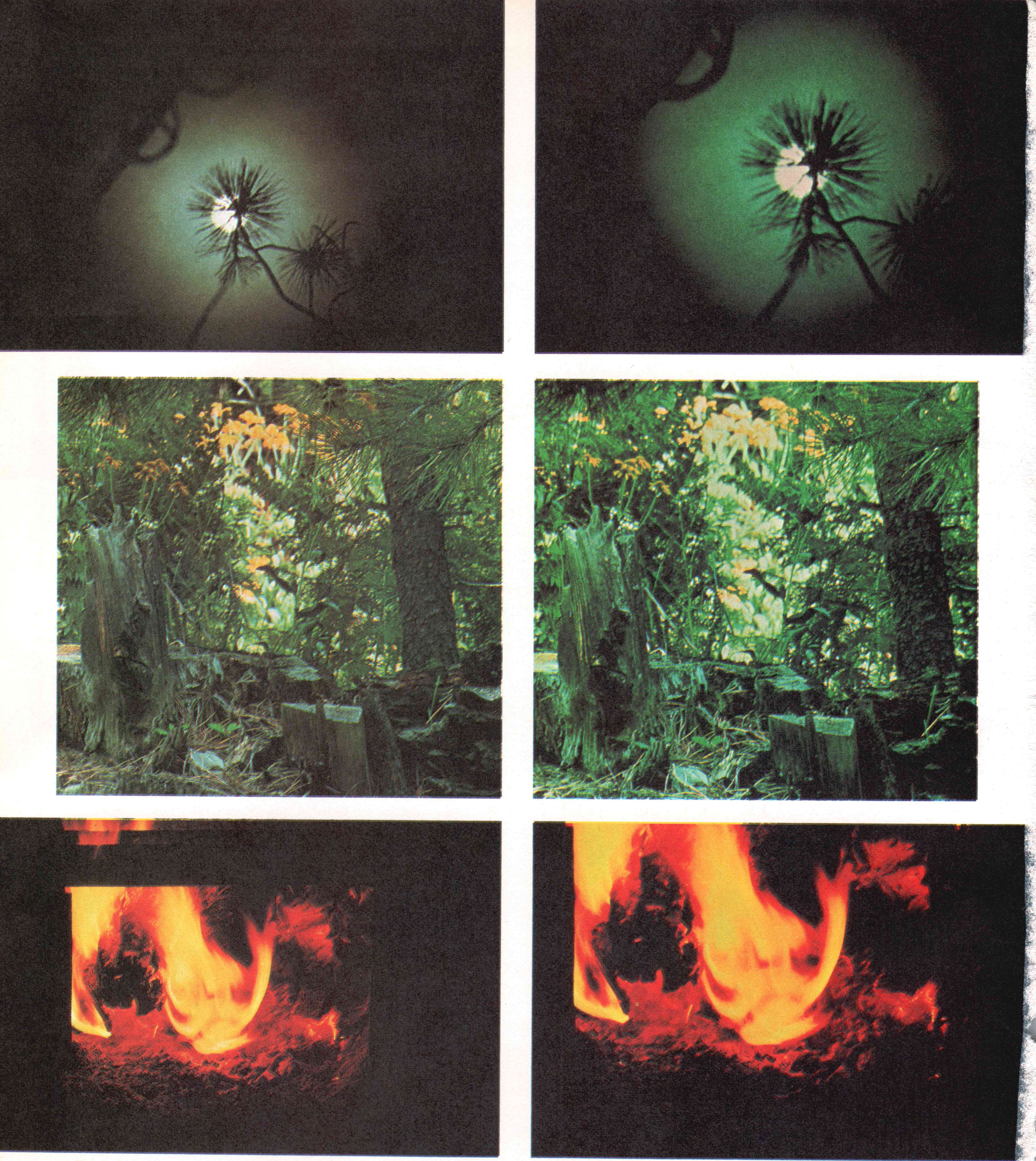
Canon Photomicro Unit F has an outer tube which replaces the camera lens. It attaches to the front of the camera the same way lenses do. There are no optics in the tube. At the opposite end are fittings which adapt to the top tube of the microscope and hold the top lens of the microscope—called the *eyepiece* of the microscope.

Photomicro Unit F has sufficient mechanical strength and rigidity to support the camera on top of the microscope.

The Canon Microphoto Hood is a telescoping light-tight tube. It is not intended to support the camera, so a copy stand is required. The copy stand supports camera and bellows in the normal way. The microscope sits on the base of the copy stand and the Microphoto Hood fits between bellows and microscope.

Focusing is possible with the microscope focus control or by changing bellows extension at the camera. Changing bellows extension is aided by the telescoping feature of the Microphoto Hood, and of course different extensions give different magnifications.

Using Microphoto Equipment—Precautions about preventing vibration are more important with increasing magnification. Use a cable shutter release and lock up the mirror before shooting. Shutter speeds between 1/2 and 1/30 cause the least camera shake, so stay in that range if possible. Canon recommends using rubber pads—3/4 to 1 inch thick—underneath the equipment set-up and between table or bench and the floor if possible. These isolate the equipment from earth-borne vibrations or those transmitted through the structure of a building.



To show what to expect from simple slide copying, I used a slide holder attachment with ordinary daylight slide film and diffused daylight as the illuminant. Originals on left, copies on right. Notice slight enlargement, increased contrast and color change. Color change can be reduced by testing and use of filters.

14

AVAILABLE CANON LENSES

It's the lens that makes the picture. The camera holds the film flat and the photographer helps as much as possible but, fundamentally, lens quality determines picture quality. Shot with the Canon 200mm f-4 lens on an A-1 camera using shutter-priority AE.

Newcomers to SLR photography sometimes become too interested in the camera body because that's where most of the gadgets are. It's the lens that makes the picture. All the body does is hold the film flat and open the shutter.

If economy is a consideration, buy a less expensive camera body rather than less expensive lenses. Buying an SLR camera with only one lens is a waste! If you intend to do that, I strongly suggest that you buy a cheaper camera with a fixed, non-interchangeable lens.

When you are no longer a newcomer, you take great pleasure and satisfaction in the versatility that you get with several lenses of different focal length—perhaps some of the zooms. You will choose lens focal length for the desired effect when you make pictures of various scenes and subjects. Lenses become the central part of your photographic equipment and everything else exists to help the lenses do their job.

You don't need to buy a lot of lenses all at once, but you should add to your collection regularly. As you use lenses of various focal lengths, you'll learn more about how to use them and you will begin to identify other focal lengths that you need to reach your goals in photography.

Canon has replaced FL lenses with FD lenses in most focal lengths. The sophisticated design of the meter-coupled FD lens series offers features not found in FL-type lenses. A prominent advantage is the mechanical lens-to-camera linkage allowing wide-open-aperture metering. This same feature also allows automatic aperture control by the Canon automatic cameras.

Aside from these operational advantages, design improvements give better picture quality. Some FD lenses use the *Floating System* which changes spacing between the glass elements inside the lens as the focusing control is operated. This reduces spherical aberration at close subject distances and improves resolving power and image contrast.

Some Canon lenses use aspheric elements and some use elements made of fluorite. Multilayer S.S.C. lens coating is also used in some FD lenses. Multi-coating is a controversial topic in more than one way. Some lens makers advertise it as an almost universal cure for lens problems—which it is not.

In many shooting situations, a good lens hood to keep light off the front surface will do more to help your picture than multi-coating. Use of single-layer *Spectra Coating (S.C.)* on some lenses and *Super Spectra Coating (S.S.C.)* on others represents Canon's judgement in balancing technical and economic factors.

LENS CATEGORIES

Most photographers think of lenses in categories such as telephoto or wide-angle. Canon also groups lenses with similar features. The paragraph titles which follow are Canon nomenclature for lens types and categories.

CIRCULAR FISH-EYE

The Fish-Eye 7.5mm f-5.6 S.S.C.

CANON LENSES

FD Series (For Full-Aperture Metering or AE Operation)

Type	Lens	Angle of View	Minimum Aperture	Closest Focusing Distance		Filter Size (mm)	Hood	Length		Weight		
				(m)	(ft.)			(mm)	(ins.)	(g)	(lbs.)	((ozs.)
Full-Frame Fish-Eye	Fish-Eye FD 15mm *f*-2.8 S.S.C.	180°	*f*-16	.3	1	Built-in	Built-in	60.5	2-3/8	485	1	1
Super Wide-Angle	FD 17mm *f*-4 S.S.C.	104°	*f*-22	.25	.9	72	None	56	2-3/16	450	1	0
	FD 20mm *f*-2.8 S.S.C.	94°	*f*-22	.25	.9	72	None	58	2-5/16	345		12
	FD 24mm *f*-1.4 S.S.C. ASPHERICAL	84°	*f*-16	.3	1	72	—	68	2-11/16	500	1	2
	FD 24mm *f*-2.8 S.S.C.	84°	*f*-16	.3	1	55	†BW-55B	52.5	2-1/16	330		12
Wide-Angle	FD 28mm *f*-2 S.S.C.	75°	*f*-22	.3	1	55	†BW-55B	61	2-3/8	343		12
	FD 28mm *f*-2.8 S.C.	75°	*f*-22	.3	1	55	†BW-55B	49	1-15/16	280		10
	*FD 35mm *f*-2 S.S.C.	63°	*f*-22	.3	1	55	†BW-55A	60	2-3/8	345		12
	*FD 35mm *f*-3.5 S.C.	63°	*f*-22	.4	1.5	55	†BW-55A	49	1-15/16	236		8
Standard	*FD 50mm *f*-1.4 S.S.C.	46°	*f*-16	.45	1.5	55	†BS-55	49	1-15/16	305		11
	*FD 50mm *f*-1.8 S.C.	46°	*f*-16	.6	2	55	†BS-55	38.5	1-1/2	200		7
	FD 55mm *f*-1.2 S.S.C.	43°	*f*-16	.6	2	58	+BS-58	52.5	2-1/16	510	1	2
	FD 55mm *f*-1.2 S.S.C. ASPHERICAL	43°	*f*-16	.6	2	58	†BS-58	55	2-3/16	575	1	4
Macro	FD 50mm *f*-3.5 S.S.C. Macro with Extension Tube FD 25	46°	*f*-22	20.5 (cm)	8.1 (in)	55	None Necessary	59.5	2-5/16	310		11
	FD 100mm *f*-4 S.C. Macro with Extension Tube FD 50	24°	*f*-32	.4	1.31	55	None Necessary	112	4-7/16	530	1	3
Short Telephoto	FD 85mm *f*-1.2 S.S.C. ASPHERICAL	28°30′	*f*-16	1	3.5	72		71	2-13/16	756	1	11
	FD 85mm *f*-1.8 S.S.C.	28°30′	*f*-16	.9	3	55	†BT-55	57	2-1/4	425		15
	FD 100mm *f*-2.8 S.S.C.	24°	*f*-22	1	3.5	55	†BT-55	57	2-1/4	360		13
Telephoto	FD 135mm *f*-2.5 S.C.	18°	*f*-22	1.5	5	58	Built-in	91	3-9/16	630	1	6
	FD 135mm *f*-3.5 S.C.	18°	*f*-22	1.5	5	55	†BT-55	85	3-3/8	385		14
	FD 200mm *f*-2.8 S.S.C.	12°	*f*-22	1.8	6	72	Built-in	140.5	5-9/16	700	1	9
	FD 200mm *f*-4 S.S.C.	12°	*f*-22	2.5	8	55	Built-in	133	5-1/4	675	1	8
	FD 300mm *f*-2.8 S.S.C. FLUORITE with Extender FD 2X	8°15′	*f*-22	3.5	12	Insertion Type	Built-in	230	9-1/16	1,900	4	3
	FD 300mm *f*-5.6 S.S.C.	8°15′	*f*-22	3	10	58	Built-in	198	7-13/16	685	1	8
	FD 400mm *f*-4.5 S.S.C.	6°10′	*f*-22	4	13	Insertion Type	Built-in	282	11-1/8	1,300	2	14
	FD 600mm *f*-4.5 S.S.C.	4°10′	*f*-22	8	27	48	Built-in	460	1′6-1/8	4,200	9	4
	FD 800mm *f*-5.6 S.S.C.	3°06′	*f*-22	14	45	48	Built-in	572	1′10-1/2	4,250	9	6
Zoom	FD 24-35mm *f*-3.5 S.S.C. ASPHERICAL	84°-63°	*f*-22	0.3	1	72	W-75	86	3-3/8	515	1	2
	FD 28-50mm *f*-3.5 S.S.C. with Macro Setting	75°-46°	*f*-22	1 .25	3.5 .9	58	†W-69B	105	4-1/8	470	1	1
	FD 35-70mm *f*-2.8-3.5 S.S.C. with Macro Setting	63°-34°	*f*-22	1 .3	3.5 1	58	W-69	120	4-3/4	575	1	4
	FD 80-200mm *f*-4 S.S.C.	30°-12°	*f*-22	1	3.5	55	Built-in	161	6-3/8	750	1	10
	FD 85-300mm *f*-4.5 S.S.C.	28°30′-8°15′	*f*-22	2.5	8	Series IX	Built-in	243.5	9-9/16	1,695	3	12
	FD 100-200mm *f*-5.6 S.C.	24°-12°	*f*-22	2.5	8	55	Built-in	173	6-13/16	765	1	11

FL and Manual Series (For Stopped-Down Metering)

Type	Lens	Angle of View	Minimum Aperture	Closest Focusing Distance		Filter Size (mm)	Hood	Length		Weight		
				(m)	(ft.)			(mm)	(ins.)	(g)	(lbs.)	(ozs.)
Circular Fish-Eye	Fish-Eye 7.5mm *f*-5.6 S.S.C.	180°	*f*-22	Fixed Focus		Built-in	None	62	2-7/16	380		13
Tilt and Shift	TS 35mm *f*-2.8 S.S.C.	63°-79°	*f*-22	3	1	58	†BW-58B	75.5	2-15/16	545	1	3
Bellows Macro	FLM 100mm *f*-4 S.C.	24°	*f*-22	Focused by Bellows		48	None	43	1-11/16	220		8
Super Telephoto	**FL 1200mm *f*-11 S.S.C.	2°05′	*f*-64	40	130	†† 48	Built-in	853	2′9-9/16	6,200	13	11
Artificial Fluorite Telephoto	FL 300mm *f*-5.6 FLUORITE	8°15′	*f*-22	4	13	58	Built-in	168	6-5/8	850	1	14
	FL 500mm *f*-5.6 FLUORITE	5°	*f*-22	10	33	95	Built-in	300	11-13/16	2,700	5	15

S.S.C. = Super Spectra Coating　**S.C. = Spectra Coating**

***Equipped with a coupling pin for Canon Auto Tuning System**

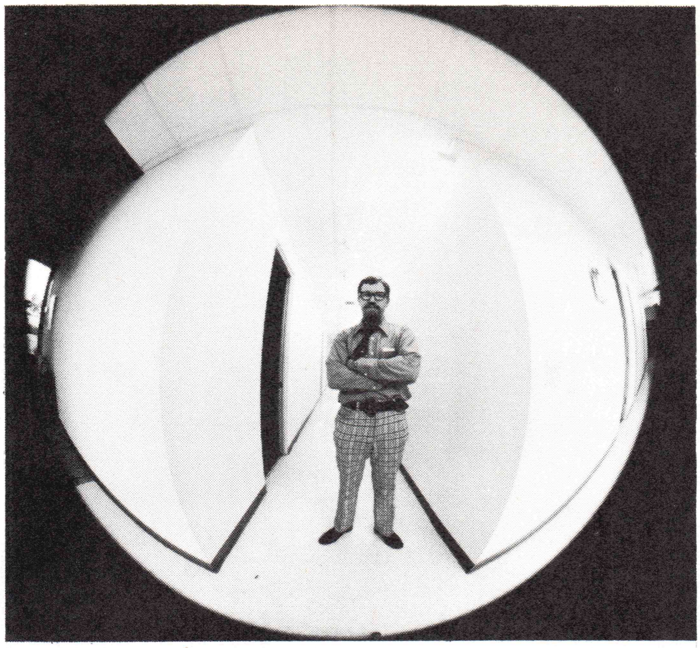
****Front component interchangeable type. Focusing adapter (2 elements, 1 group, FL automatic diaphragm, with A-M ring)**

†FD lens hoods are of bayonet mount.

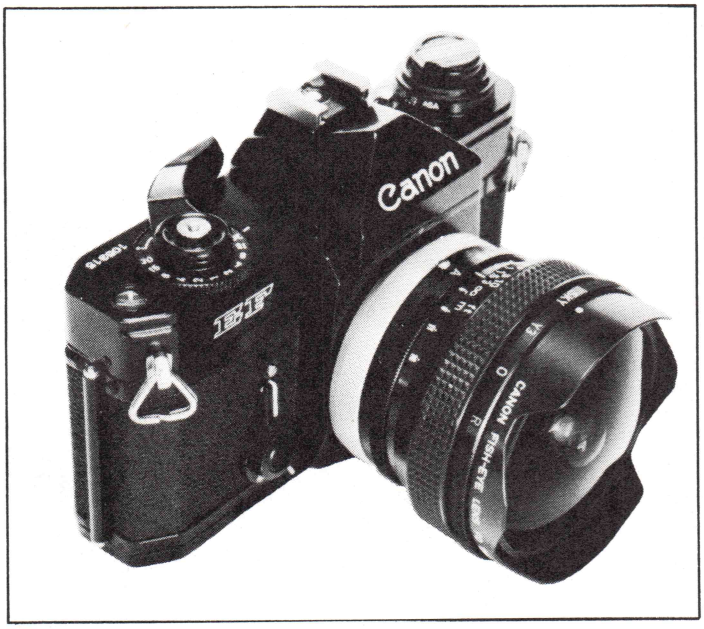
††Filter is of insertion type with holder.

†††Macro focusing capability to 30 cm (1 ft.) from film plane.

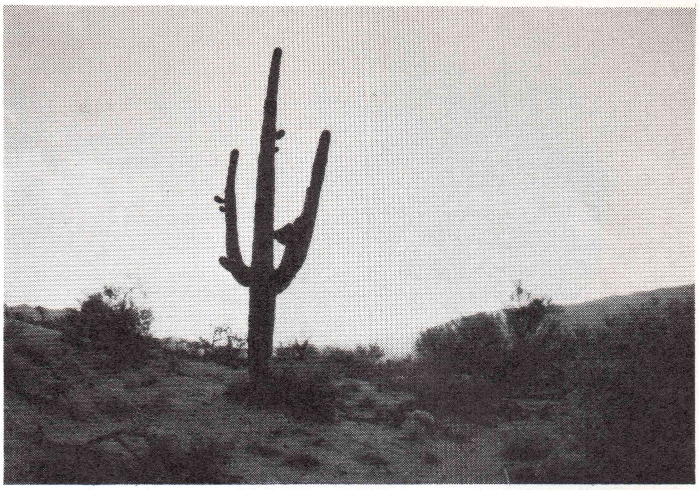
Subject to change without notice.

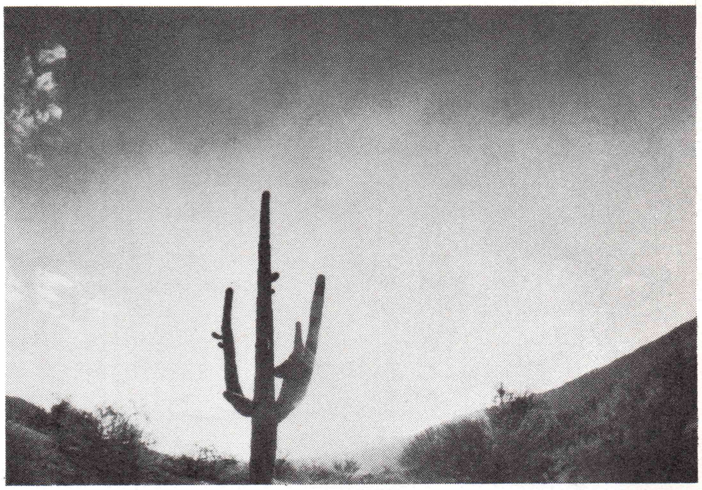


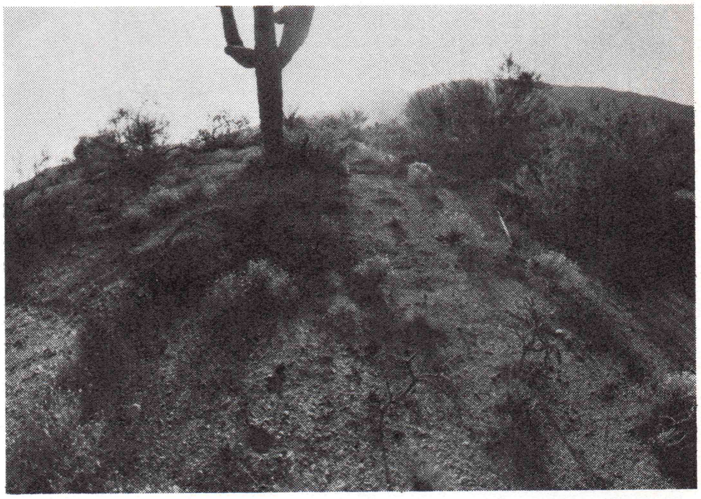
Circular 180° image made by 7.5mm Fish-Eye fits *inside* the normal 35mm film frame. John Wall, Canon tech-rep, stands in corridor leading into a large room. Lens sees 90° to left and 90° to right, along the walls of the room.



Canon 15mm Fish-Eye also makes a circular image but it overhangs the sides and top of film frame, so it gives a full-frame rectangular picture. Permanently-attached lens hood is cut away at corners of picture so not to obstruct the 180° view where it's actually used on the film—diagonally.







Except where scene includes definite vertical and horizontal lines, a full-frame fish-eye lens can be used without calling attention to the fish-eye distortion—top photo.

Most fish-eye distortion occurs off of the center or axis of the lens. Point a fish-eye upward so the horizon is below center and it curves visibly—center photo.

Point the lens downward and the effect reverses. All three of these pictures were taken with the same 15mm Fish-Eye lens and from the same camera position.

CANON FISH-EYE LENS 7.5mm

The 7.5mm Fish-Eye takes a 180° view in all directions. A lens hood or even a filter ring will intrude into the picture area and reduce the angle of view.

lens has an angle of view of 180 degrees—90 degrees each side of the lens axis. It distorts visibly, causing vertical and horizontal lines to curve and similarly distorts natural objects such as trees and people. The distortion of natural objects may not be as noticeable.

Shorter focal lengths have greater depth of field. At 7.5mm focal length, this lens has depth of field from very near the lens all the way to infinity, so there is no need for a focus control. It is a fixed-focus lens, set at the hyperfocal distance.

Because of the 180-degree field of view, any forward projection around the lens, such as a lens hood, will vignette the image. No lens hood is used. Because filters mounted at the front of the lens would also vignette, six internal filters are built into the lens on a turret. By an external control you can select from Sky, Y3, O, R, CCA4 or CCB4. These are Canon filter designations—see the table on page 124. Canon service facilities can change these filters to other types, but designations engraved on the control will stay the same.

To make an image with 180-degree coverage in all directions, the image must be circular. The 23mm circular image made by this lens cannot fill the 35mm film rectangular frame. Outside of the circle, the film is unexposed.

Both the 7.5mm Fish-Eye and the 15mm Fish-Eye discussed below are retrofocus designs which install on the camera *without* interfering with normal mirror operation and viewing.

Aperture control of the 7.5mm Fish-Eye is completely manual. It is not stopped down by the camera mechanism at the instant of exposure. Stopped-down metering is used. This lens is useful for astronomical photography and special effects.

FULL-FRAME FISH-EYE

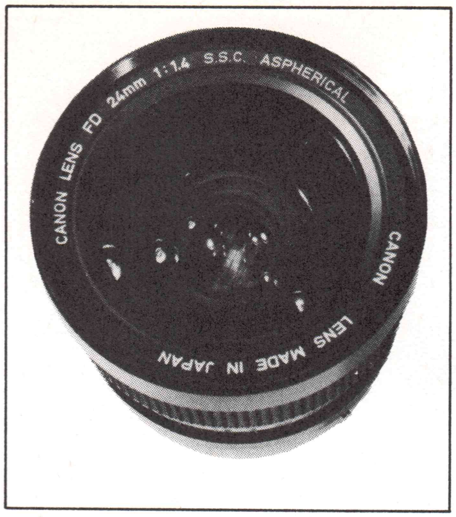
The FD 15mm ƒ-2.8 S.S.C. Fish-Eye lens also has a 180-degree angle of view, but the image circle at the film plane completely fills the frame. The sides, top and bottom of the image circle are cut off and *the 180-degree field of view exists only on the diagonal of the frame.*

A shaped attached lens hood shades the lens on the sides, top and bottom, but the hood is cut away at the corners so it doesn't obstruct the 180-degree viewing angle. This lens has four built-in filters: Sky, Y3, O and R. These can also be changed but the control markings cannot.

Because it fills the frame, it doesn't call attention to the fact that it is a fish-eye as much as the 7.5mm lens although the same type of image distortion exists. Interesting and unusual wide-angle views result from use of this lens and it is generally more useful than the circular fish-eye. Even though it has a maximum aperture of ƒ-2.8, this is one of the smallest fish-eye lenses available and it has many uses. Controls and operation are the same as for any other FD lens.

SUPER-WIDE-ANGLE LENSES

Canon offers a series of lenses covering angles of view from 104° to 64° in steps of approximately 10°. Super-wide-angle lenses are the FD 17mm, 20mm and 24mm with angles of 104°, 94° and 84°.



One of the Super-Wide-Angle lenses is this 24mm Aspherical.

These lenses do not have fish-eye distortion and are useful for shooting in limited space, photographing groups of people, interiors, buildings, and for the special impact of wide-angle scenic views and nature. Incidentally, lenses which do not cause straight lines to curve are called *rectilinear.*

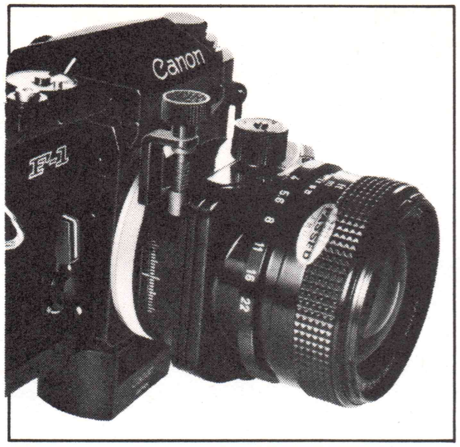
WIDE-ANGLE LENSES

Two focal lengths, 28mm and 35mm, have viewing angles of 75° and 63°. Because of their inherently large depth of field, lenses in these focal lengths are good for candid and snapshot photography in addition to interiors and general use. Because photos made with 35mm focal length are not extremely wide-angle, many photographers use a 35mm lens as the normal camera lens.

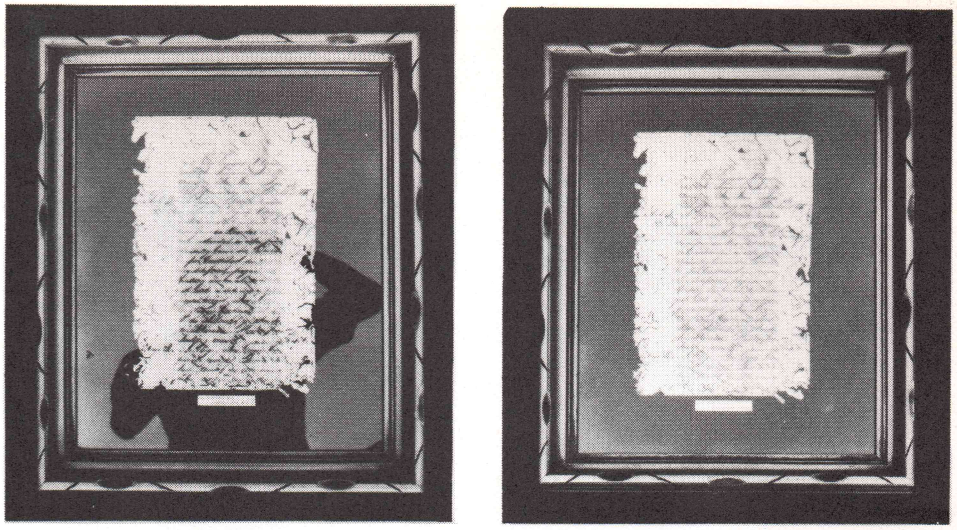
TILT AND SHIFT

Some features of the TS 35mm ƒ-2.8 S.S.C. were described in Chapter 10. This lens tilts in one direction and swings at right angles to the tilt direction—that is, if it tilts vertically it swings horizontally. The entire lens rotates on its mount so it can be set to swing and tilt in any orientation. If you need it to tilt and swing both in the same direction, it can be modified by Canon Authorized Service Facilities.

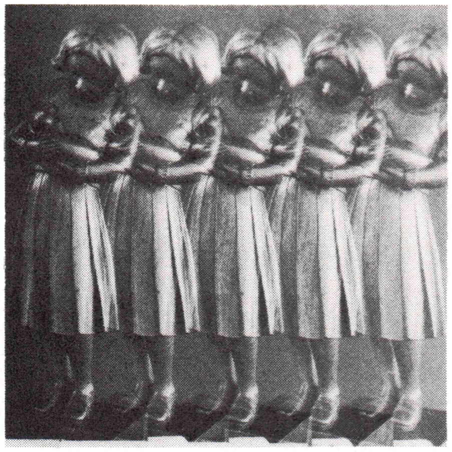
The lens mounts in the normal way on the camera, but a tripod may limit the range of tilt or swing



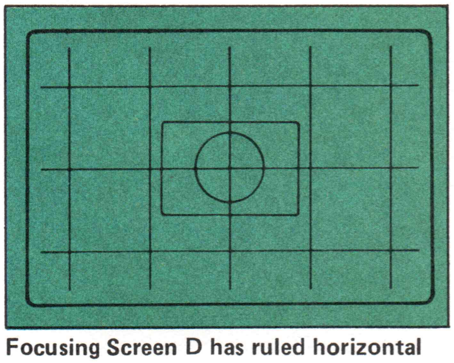
Shift lenses are fairly common for 35mm cameras. A lens that *shifts and tilts* is unusual. This is the Canon TS 35mm *f*-2.8 S.S.C. mounted on an F-1.



Sometimes, if your shadow or reflection is in the picture, you can use the TS lens to shift yourself out. Camera was moved and lens shifted for the right photo but the two pictures are essentially the same—except for the reflection.



Shifting the TS lens between multiple exposures makes an unusual photo.



Focusing Screen D has ruled horizontal and vertical lines which help with architecture and in copying documents. Interchangeable focusing screens are a feature of the F-1 camera.

movement. A Tripod Adapter furnished with the lens fits between camera and tripod to give adequate clearance.

Mechanically this is a pretty busy lens with movement in two directions plus rotation, so aperture control is manual. Use it with stopped-down metering.

The TS lens makes a large image circle and when either or both of the adjustments are used the result is a picture made with light from the edge of the image circle rather than the center. Because the light falls off more rapidly at greater distances from center, uneven illumination may be visible in the photo. Shooting at small aperture will help some, but nothing can entirely eliminate the effect. Because of light variation across the frame, exposure metering is not as precise as with other lenses, which may require bracketing exposures, testing to find correct settings, and good photographic judgment on your part.

With an F-1 camera, interchangeable focusing screen D is recommended for use with the TS lens. The vertical and horizontal lines in this screen serve as reference lines when photographing architecture. Because biprism and microprism focusing aids depend on ray angles, they may not work properly when using the TS lens. Shifting the lens will not affect their use but, in general, you are better off observing the entire image on the viewing screen to judge focus and composition.

Use of this lens to correct architectural views is important, but don't think of it as a lens exclusively for that purpose.

Instead of using the tilt feature to improve focus of an angled surface or row of objects it can be used the other way to cause dramatic out-of-focus effects for everything except the subject of main interest in the photo.

STANDARD LENSES

50mm or 55mm focal lengths are standard for Canon 35mm cameras, meaning they give a view we accept as normal or usual. One of these lenses is supplied with a camera unless the buyer makes other arrangements.

The main differences among standard lenses are aperture and optical quality. The FD 50mm *f*-1.8 S.C. is lowest-priced. It will give complete satisfaction to many camera users. The 50mm *f*-1.4 is nearly as popular because of its

Important lens accessories: Lens hood, lens cap and rear cover. Rear cover is called Dust Cap R-F for most lenses. Lens hood nomenclature is BW, BS or BT, followed by lens accessory thread diameter—such as BS 55 for a lens that uses 55mm filters. W is for wide-angle lenses, 35mm and shorter. S is for standard lenses, 50 and 55mm. T is for telephoto lenses, 85mm and longer. These hoods use a bayonet twist-to-lock mount on the outside of the lens and do not interfere with use of filters or other screw-in accessories. Some lenses have permanently-attached hoods.

better light-gathering capability. If you often shoot in dim light, one of the larger-maximum-aperture lenses may be worth the extra cost and weight—such as the 50mm *f*-1.2 S.S.C.

The star performer in this category is the FD 55mm *f*-1.2 AL S.S.C., where AL means *Aspheric Lens.* It is an outstanding lens in every respect with suppressed spherical aberration, unusually large aperture and superb image quality.

When selecting the lens for your new camera, you should first decide if you want a 50mm or 55mm focal length. If so, you have several to choose from and the choice may be difficult. Don't buy less lens than you need, but don't waste your money by purchasing more than you need. If you are sure you will use the larger aperture or better performance of the more expensive standard lenses, get the better lens when you buy the camera. Remember, lenses with better light-gathering capability weigh more.

You can buy a camera body with any of the standard lenses, by specifying the lens you want. Or you can buy a camera body only—without lens—then choose whatever lenses you want.

As a standard lens, you should consider the 50mm Macro. Because I enjoy high-magnification photography and do some close-up product photography for publication, I have switched to the 50mm Macro and have another 50mm lens I don't use much anymore.

MACRO LENSES

With the FD 50mm *f*-3.5 S.S.C. Macro lens, you have about two stops less light-gathering ability than the *f*-1.8 and about three stops less than the *f*-1.2 lens.

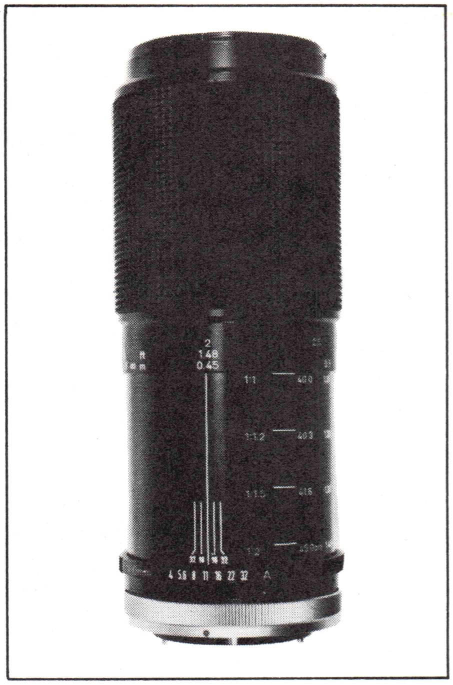
Obviously this can be a handicap when shooting action in dim light, but otherwise it is not a problem. Most photography is done at apertures smaller than *f*-3.5.

When using this lens for high-magnification work you will probably use artificial lighting anyway to get more light on the subject and to control shadows and modeling of surface features. Try to get enough light to use *f*-8 or *f*-11 for best image quality.

The big advantage of this lens is a magnification of 0.5 with no accessories and no time spent fiddling. Crank the long-travel focus control out to full extension and you get an image on the film which is 50% as large as real life. That's handy!

When a Life-Size Adapter (Extension Tube FD 25) is used with the 50mm Macro lens, read magnification from a scale on the lens barrel. This scale is gradually exposed as the lens is cranked out for nearer subjects. The scale shows a magnification range from 0.5 to 1.0.

Canon Macro FD 100mm *f*-4 S.C. has the same basic features as the 50mm Macro. For the same magnification, this lens gives more distance between lens and subject than the 50mm Macro. Extension Tube FD 50 gives life-size images and preserves all automation.



For current Canon macro lenses, magnifications up to 0.5 are read on focus scale. Magnifications between 0.5 and 1.0 (1:2 to 1:1) are read from scale on lens body.

This lens comes with a Life-Size Adapter—basically a 25mm extension ring which preserves aperture automation.

Because the focus control moves the lens, it also affects magnification. Therefore this lens shows magnification by a separate set of numbers engraved on the focus scale. Without the Life-Size Adapter, the magnification scale *reads* from 1/10 to 2 according to where you have set focus. The whole numbers are denominators of fractions whose numerator is one. Magnification varies from 1/10 to 1/2 as you change focused distance.

Early Canon 50mm macro lenses came with a Life-Size Adapter which did not preserve the automatic features of the lens and mounted the lens upside down. When upside down, a second aperture scale became visible. This scale had different *f*-numbers, to show the light loss due to use of the Life-Size Adapter.

Current 50mm macro lenses come with a re-designed Life-Size Adapter which *does* preserve the automatic features of the lens—both automatic aperture and full-aperture metering. The lens mounts right-side-up and no special scale of *f*-numbers is engraved on the lens. This lens works the same way on the camera with, or without, the Life-Size Adapter.

This lens is corrected for close-up and macrophotography, including flatness of field so you can copy documents and photograph such things as stamps without the edges going out of focus. In the macro range—larger than life-size—the lens should be reversed. The handiest way is the Macrophoto Coupler FL and Macrohood.

The FD 100mm *f*-4 S.C. Macro lens should be considered if you already own a normal 50mm lens or if the advantage of longer subject distances is important to you. The 50mm extension tube which comes with this lens preserves full camera automation.

BELLOWS MACRO

The FLM 100mm *f*-4 S.C. lens has no built-in focusing mechanism and is intended for use on either of the Canon bellows.

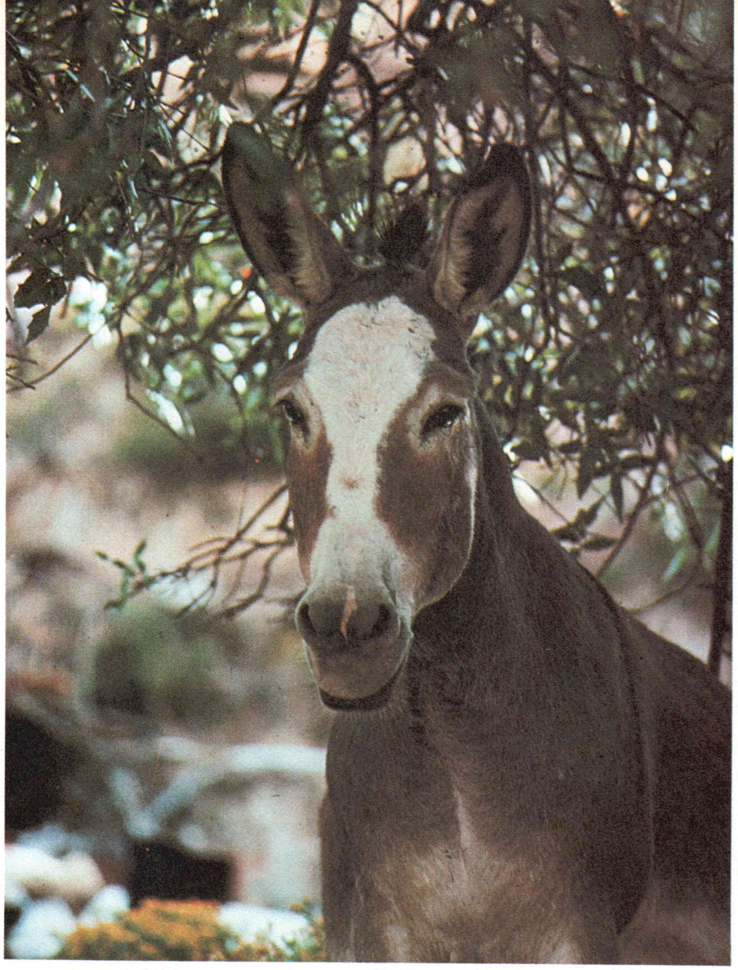
For use on a bellows with lots of extension available, a 100mm lens is a good compromise between magnification and working distance between lens and subject. This lens is also corrected for close-up and flatness of field.

A slide-button on the barrel is marked A (Automatic) or M

COMBINATIONS OF CAMERAS AND LENSES—Many older Canon cameras and lenses not covered in this book, are still in use around the world. This table covers use of older lenses with recent cameras and recent lenses with older cameras.

CAMERA	LENS TYPE		
	FD	FL	R
A-1 AE-1 AT-1 EF TX F-1 TLb FTb	Full aperture metering Automatic aperture	Stopped down metering Automatic aperture	Stopped down metering Manually operated aperture
FT PX	Stopped down metering Automatic aperture	Stopped down metering Automatic aperture	Stopped down metering Manually operated aperture
FX	External light metering Automatic aperture	External light metering Automatic aperture	External light metering Manually operated aperture
RM, R2000, RP, R	External light metering Manually operated aperture	External light metering Manually operated aperture	External light metering Automatic aperture

The FLP 38mm *f*-2.8 lens which was developed for the Pellix cannot be used on the F-1.



Advantages of a 200mm lens for this photo include: The reduced depth of field helps put background out of focus, allowing the viewer to admire the subject without distraction. Also, longer focal length gives more distance between photographer and subject.

(Manual). When set at M, aperture control is manual at the lens. When set at A and used with Bellows FL, aperture is stopped down automatically by the camera at the instant of exposure. Either way, use stopped-down metering.

SHORT TELEPHOTO

These are the 85mm and 100mm focal lengths. Both are fine portrait lenses for two reasons. One is, you don't get as close to your subject as with the 50mm lens which sometimes eases the tension of a portrait session and allows your subject to relax more.

The other reason relates to distortion of facial features by short subject distances. A very short lens, such as 17mm or 24mm, is often used to create a sort of caricature photo with an exaggerated nose or chin. We usually think these pictures are funny even if the subject doesn't.

A 50mm lens has the same effect in portraiture—but to a less noticeable amount. Nevertheless it is there if you look for it, particularly if you compare the shot to another taken with a long lens. Most photographers agree that an 85mm or 100mm lens makes a more pleasing and natural-looking portrait. These lenses are also useful in general photography including nature and scenic views.

TELEPHOTO

These are 135mm and longer lenses. The 135mm focal length is popular because it can also be used for portraiture, sports and other general telephoto applications. Longer focal lengths give higher magnification without any accessories but as focal length is increased there are usually two penalties: The closest focusing distance of the lens gets pretty far away, and the maximum aperture size is reduced significantly.

For general photography including sports, nature and scenic views, you need telephoto focal lengths. I often use the FD 200mm.

In most focal lengths there is more than one lens design to choose from. Differences include maximum aperture, lens coating, optical design, mechanical design, size, weight and price. This allows the user to choose a lens best suited for his application whether the choice is based on technical reasons or budget.

Four recently developed lenses, the FD 300mm *f*-5.6 S.S.C., the FD 400mm *f*-4.5 S.S.C., the 600mm *f*-4.5 S.C., and the 800mm *f*-5.6 S.S.C., show a new trend in telephoto lens design. They are very compact and focus by moving rear

The new Canon rear-focusing telephoto lenses are very compact compared to earlier designs. As an example, this FD 300mm *f*-5.6 S.S.C., is only 6-3/4 inches long, and weighs only 1 lb., 7.5 oz.

elements of the lens inside the lens tube so the lens remains the same overall length at any focused distance. They focus with an internal cam rather than a screw thread. The cam gives quick focusing from near to far and also focuses more slowly at farther distances so the focusing control is not unduly sensitive for distant subjects. These lenses give the photographer more telephoto range in a smaller package.

SUPER TELEPHOTO

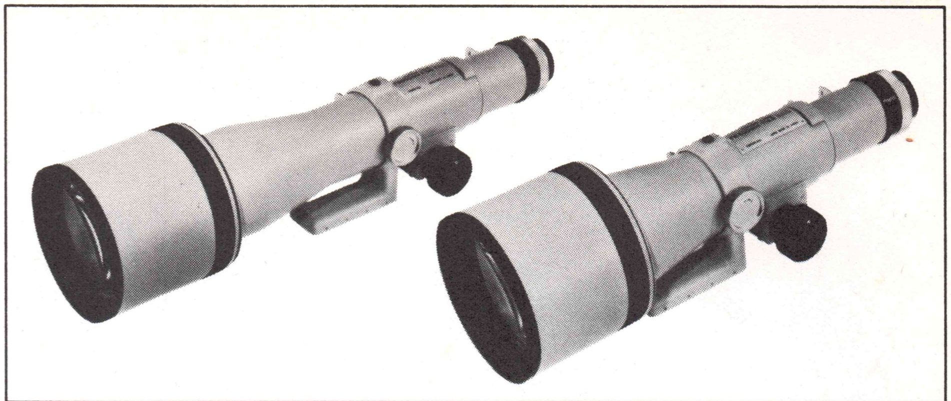
You can reach distant subjects easily with the FL 1200mm *f*-11 S.S.C. Super Telephoto Lens. This lens has two parts that fit together to make the complete lens. A Focusing Adapter fits on the camera body and contains the aperture and focusing mechanism. Because it's an FL type, there is a lever for automatic diaphragm operation. You attach the optical part of the lens to the front of the adapter when setting up to use the lens. This has the narrowest angle of view of any Canon lens: about 2.1 degrees.

With very long focal lengths, you can get a full-frame image of a subject so far away that you have to worry about the amount of air between lens and subject. If the intervening air is turbulent or polluted, it can fuzz up the image. Even with clear air, a blue haze may appear in the photo.

FLUORITE TELEPHOTO

These fall into both telephoto and super telephoto ranges, but they are grouped because all use a fluorite element in the lens, indicated by the -F in the lens nomenclature. The fluorite lens element is a man-made crystal with special optical qualities.

Canon specs say the secondary spectrum is eliminated and these lenses are *apochromatic.* You may want a translation: Chromatic aberration means all colors of light are not brought to focus at the same plane. If not corrected, it causes color images to have a fringe of colors around the edges, which you can see around the light spot made by any household magnifying glass. In black-and-white, chromatic aberration fuzzes up the image because some of the light is not in focus where it should be—on the film.



Canon lenses at focal lengths of 300mm and longer come with tripod mounts which support the lens near its balance point. These are the FD 600mm *f*-4.5 S.S.C. and FD 800mm *f*-5.6 S.S.C. Both use internal focusing so overall length doesn't change. They offer relatively large aperture and light weight.

Conventional lens designs suppress chromatic aberration at two colors of the spectrum, meaning that both colors come to focus at the film. All other colors still exhibit some chromatic aberration and this is called the *secondary spectrum.* It has a bad effect on both color and b&w pictures. Through the unusual optical properties of fluorite, Canon is able to also suppress the secondary spectrum in these lenses to keep chromatic aberration imperceptible over the entire range of colors we can see.

Apochromatic means a sophisticated lens design in which chromatic aberration is brought near zero at three colors instead of two. There will still be a secondary spectrum at other colors unless it is suppressed.

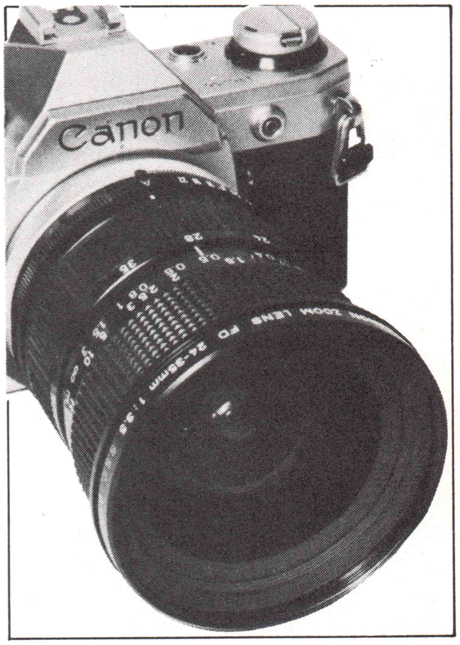
What this means in practical terms is, these lenses make excellent pictures.

ZOOM LENSES

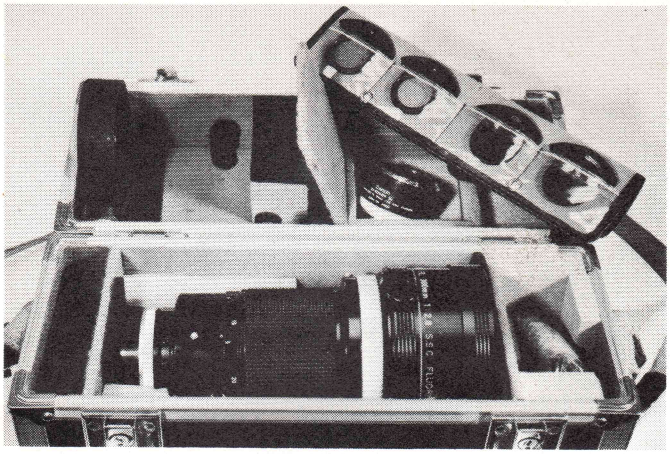
The two focal lengths in the specification such as 35–70mm are the shortest and longest focal lengths of the zoom range. *Zoom Ratio* is the longest focal length divided by the shortest, so it is one indicator of the versatility and potential usefulness of the lens. With a zoom ratio of 2, you can make the image twice as large by using the full zoom.

The main advantage of zooming is the ability to change focal lengths in a hurry. If you intend to shoot sports or other action where things happen quickly and at varying distances from the camera, a zoom lens is the only satisfactory way to improve your shooting score.

They are convenient for making a wide-angle view of a scene—which movie makers call an *establishing*



Canon zoom lenses now cover every focal length from 24mm to 300mm. This is the FD 24-35mm *f*-3.5 S.S.C.



The 300mm *f*-2.8 comes in its own fitted case with its special 2X tele-extender, a tripod bracket and a set of special drop-in filters which fit into a slot near the back of the lens. One is clear glass, used when no other filter is needed, to keep the amount of glass in the optical path the same at all times. Always use one of the filters.

Canon zoom lenses operate in one of two ways. The 35–70mm at left and 85–300mm at right both zoom by rotating the zoom control. The 100–200mm in the center zooms by sliding the front part of the lens forward and back. All have a scale to show the focal length being used.

shot—and then zooming in for a close-up of a person or some feature of the scene. You can do the same thing with two fixed-focal-length lenses unless you have to do it in a hurry.

There is a penalty in lens light-gathering ability with zoom lenses. In the data table at the beginning of this chapter, you can see the zoom lenses have smaller maximum apertures than most fixed-focal-length lenses in the same range. Zoom lenses are also heavier and usually longer.

Some photographers cling to fixed-focal-length lenses because of concern over image quality. For many years it was true that zoom lenses produced poorer image quality than fixed lenses. However recent advances in optical materials, lens design and lens coating have made zoom lenses virtually equal to fixed lenses in image quality. In ordinary photography it is difficult or impossible to see any difference.

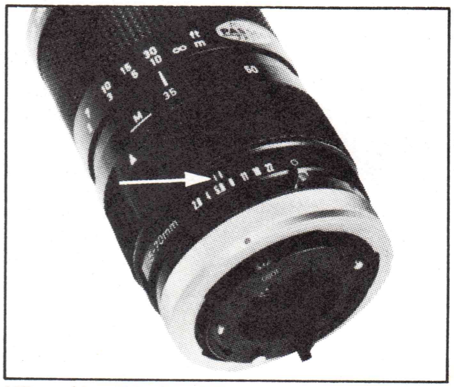
Canon now offers high-quality zoom lenses with focal lengths to cover nearly every application. Available lenses include 24–35mm, 28–50mm, 35–70mm, 80–200mm, 85–300mm and 100–200mm. With three zooms, for example, you can cover nearly every focal length from 24 to 300mm.

Once you try a zoom lens, you'll probably agree they are so useful and such an aid to creative photography that you want some in your gadget bag. If so, then you must decide how to intermingle zoom lenses and fixed-focal-length lenses. The main problem with zooms is relatively small maximum aperture and you will find some photographic situations where a zoom won't open up enough to do the job. One solution to this potential problem is to have a zoom lens for general use and one larger aperture fixed lens with a focal length somewhere near the middle of the zoom range. That gives you one large aperture lens you can use when you need to.

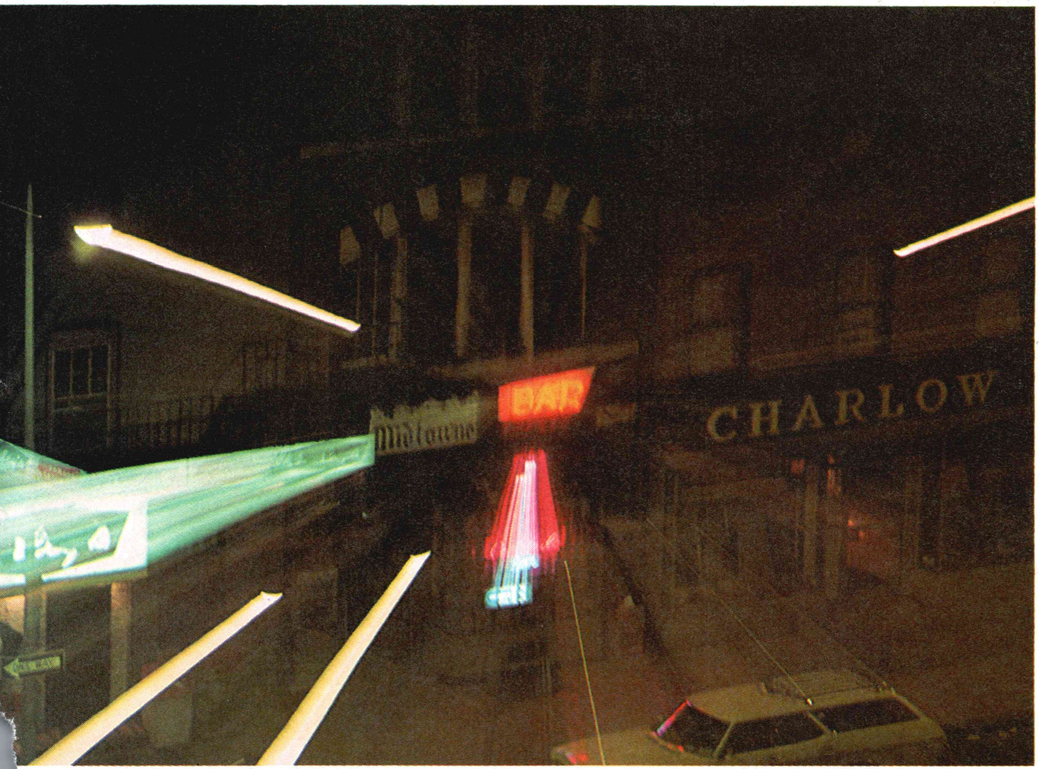
For example, the FD 80–200mm *f*-4 S.S.C. is a very popular zoom, useful for travel and sports photography. In dim light, the FD 135mm *f*-2.5 S.C. gives you a similar focal length with 1.5 steps larger aperture.

The FD 24–35mm *f*-3.5 S.S.C. doesn't sound like it zooms very much until you realize that it covers three of the fixed focal lengths. Because these focal lengths are retrofocus lenses, wide-range zooming is technically difficult and good image quality requires special measures. Canon solved the image quality problem by using an aspheric element in the lens to reduce aberrations and maintain good image sharpness, contrast and color correction.

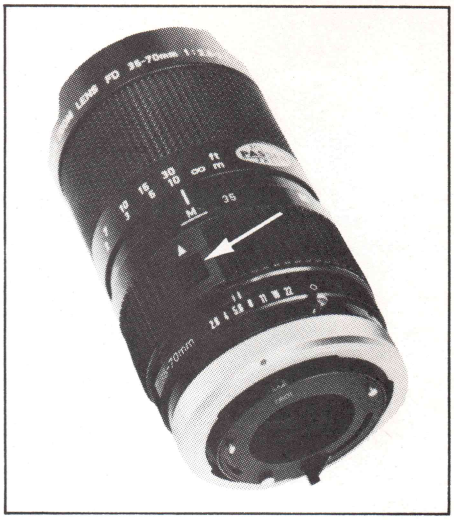
The FD 35–70mm zoom lens does not have constant aperture over the zoom range. When set for 35mm focal length, the maximum aperture is *f*-2.8. As you zoom to 70mm focal length, maximum aperture gradually changes to *f*-3.5—about half an exposure step. If the lens is used with a through-the-lens exposure measuring system and the exposure controls are set after



When the FD 35–70mm zoom is set for a focal length of 35mm, aperture is read using the left mark of the pair of index marks (arrow). When set for 50mm, aperture is read between the two index marks. At 70mm, read opposite the right-hand index. If you are using internal metering, you aren't reading *f*-stops at the lens anyway, so which index to use is not important.



Josh Young zoomed during exposure of this night scene in Baltimore. Zoom effect shows more on bright lights so choose the scene carefully if you are going to do this.



Lens makers have produced a "new breed" of zoom lens with a *close-focusing* setting. One maker called this a *macro* setting, and others did the same even though magnification is not greater than 1. To put the 35–70mm lens into the macro setting, push the slide-button (arrow) while rotating the focal-length control to M. M setting results in magnification on negative of about 0.2.

zooming, the change in *f*-stop is automatically compensated—also by the automatic cameras.

As I said in the Servo EE discussion, it is necessary to set a dial on the finder to the maximum aperture of the lens in use to compensate metering for the maximum aperture size of the lens.

When the 35–70mm zoom is used with the Servo EE Finder, it gets complicated because the maximum aperture of the lens changes when you zoom and there is no handy way to tell the finder about that. The solution is to restrict apertures used according to the *f*-number dialed into the Servo EE Finder. See the accompanying table.

CHOOSING A SET OF LENSES

There are no fixed guidelines and basically it's every photographer for himself, but here's a rule I think makes sense. When you add a new fixed-focal-length lens, either double or halve (approximately) the focal length of a lens you already own. If you own a 100mm and want a longer focal length, try a 200mm. A 35mm lens is not different enough from a 50mm to justify owning both unless you have a good reason.

Using the rule of thumb, there are two possible sets of focal lengths in which each lens is approximately double the focal length of the next shorter: 17 or 20, 35, 85, 135, 300mm, and 24 or 28, 50, 100, 200, 400. Of course, zoom lenses can replace some of these focal lengths.

Most books, including this one, show pictures taken with lenses of various focal lengths, but they are a poor substitute for actually looking through the lens to see what it really does.

If you are an active photographer with a variety of photographic interests, you need more than one lens.

USING THE 35–70 ZOOM LENS WITH THE SERVO EE FINDER

f-stop set on the Servo EE Finder	Usable *f*-stops at 35mm	Usable *f*-stops at 70mm
f-2.8	Entire Range	From maximum *f*-stop to *f*-16 + 1/2 stop
f-3.5	*f*-3.5 to *f*-22	Entire Range

All Canon lenses except the standard 50mm or 55mm focal lengths are normally sold complete with case. Canon lenses from 24mm to 100mm fit into the same size case.

15
LIGHT, FILTERS AND FILMS

Several characteristics of light affect equipment and technique when taking pictures.

COLOR OF LIGHT

We call direct light from the sun *white.* It is composed of all the colors in the visible spectrum. Light appears to travel in waves, similar to waves in water, which have different wavelengths. Different wavelengths appear as different colors in human vision.

The accompanying drawing of the visible spectrum shows colors of light and their approximate wavelengths—Figure 15-1, page 105.

Human vision does not actually respond to all colors of light. We see only three colors: red at the long-wavelength end of the spectrum, green in the middle, and blue at the short-wavelength end. The sensation of other colors is produced in the mind by noting the relative proportion or the mix of these three *primary colors.*

Beyond the visible blues in the spectrum are shorter wavelengths called *ultraviolet,* abbreviated UV.

When white sunlight is separated into its components by a prism or rainbow, we see the colors of the visible spectrum.

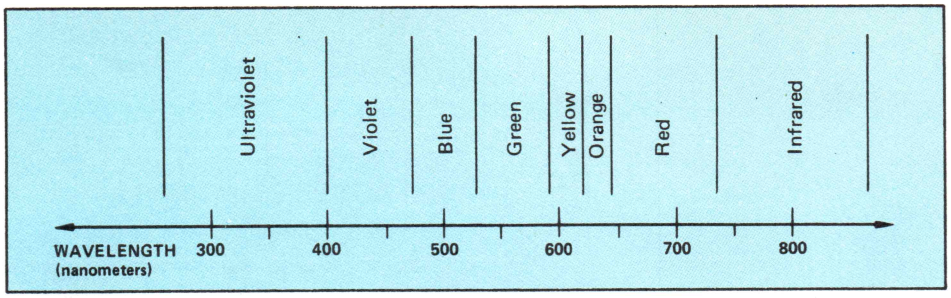


Figure 15-1/The difference between one color and another is wavelength. Long waves cause the sensation of red; short waves cause blue; green is in the middle.

We can't see them, but film can and most types of film will be exposed by UV. When you expose ordinary film, color or b&w, in your camera, some exposure results from light you can see and some from UV wavelengths you can't see. At times this is a technical problem and there are technical solutions.

Most films do not respond to wavelengths longer than visible red, called *infrared* or IR, but some special films do. You have probably seen photos taken with IR-sensitive film and noticed that natural objects such as water and foliage do not photograph the same in IR as in visible light.

LIGHT SOURCES

Not all light sources produce the entire spectrum of light. There are two main categories of light sources. Those which produce light due to being heated are called *incandescent.* Light sources which use a heated filament—such as a light bulb—are called *tungsten* sources because the filament is made of tungsten.

The other category of light sources does not depend on temperature to make light. These are sources such as fluorescent lamps and the yellowish sodium-vapor lamps used to illuminate highways and streets. The quality of light from non-incandescent sources is often a problem with color film.

COLOR TEMPERATURE

The light produced by an incandescent source—including the sun—depends on its temperature. By stating the temperature of the source, the color balance of the light is implied. When so used, the temperature of the source is stated in degrees Kelvin (K).

Figure 15-2 is the spectrum of several color temperatures. The main thing to observe is that low temperatures produce mainly long wavelengths of light which we see as red, orange and yellow.

As color temperature increases, the amount of long-wavelength light increases a small amount but the amount of short-wavelength light increases a much larger amount. At a high color temperature, the light appears to be more blue than red. Light from the sky is a very high color temperature and it is blue.

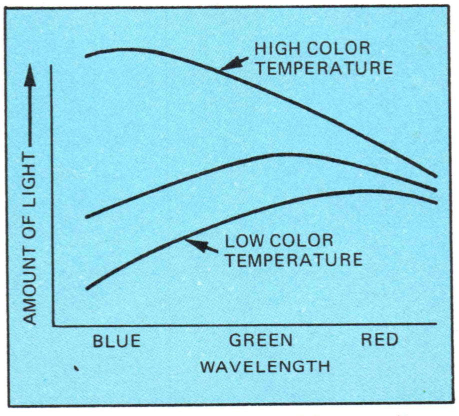


Figure 15-2/Incandescent objects radiate light because they are hot. Low color temperatures mean long wavelengths and reddish light. High color temperatures result in bluish light.

So far this is all technical and not very practical. However, in practical photography you worry about color temperature in one of two ways. For ordinary photography, you think of it in general terms: Is the light warm-looking and made up of red and yellow colors or is it cold-looking and bluish? Are you shooting outdoors under the blue sky, or indoors with warm tungsten illumination?

If you do technical photography where exact color rendition is important, you worry in more detail and use color temperatures to make equipment choices. Color temperatures are disguised in the technical term *mired.* A discussion of these matters is in my book *SLR Photographers Handbook.*

Color temperatures are just labels to indicate the color quality of light. You can use them or not, as you choose, depending on how scientific you want to get about picture-taking.

You can talk about the warm color of candle light or a color temperature of 1,800 degrees. If you say 3,200 or 3,400 degrees, some people will know you are talking about the light produced by the two types of photoflood lamps used in photography. They have a higher color temperature than ordinary room lamps.

Sunlight alone is about 4,500 degrees but the cold-looking blue light from the sky may be around 12,000 degrees. Therefore *combinations* of sunlight, light from the blue sky and a few puffy white clouds—which we call average daylight—is between those two color temperatures. It is about 5,500 to 6,000 degrees. Light from an electronic flash simulates daylight.

A subject in the shade of a tree is illuminated only by the blue light from the sky without the "warming" benefit of direct sunlight. We think the light is cold-looking and too blue.

THE COLORS OF THINGS

A white piece of paper reflects whatever color of light falls on it.

APPROXIMATE COLOR TEMPERATURES OF COMMON LIGHT SOURCES (degrees Kelvin)

Setting sun	1,000K approx.
Burning candle	1,800K
Household incandescent lamps	2,500 to 3,000K
Professional photo lamps	3,200 and 3,400K
Clear flash bulbs	4,000K
Direct sunlight at mid-day	4,500K
Commercial theater motion picture projector lamps	5,000K
Average daylight (sun, sky, and random clouds)	5,500 to 6,000K
Electronic flash	6,000K
Sun and blue sky	6,500 to 7,000K
Blue sky only (no direct sunlight)	8,000 to 20,000K or more

If illuminated by white light, it looks white. If illuminated by red light, it looks red.

Things which don't look white may owe their color to the light which is illuminating them, or to a property known as *selective reflection.* That means they do not reflect all wavelengths of light uniformly. A blue cloth in white light looks blue because it reflects mainly blue wavelengths. The other wavelengths of white light are absorbed by the cloth.

The color of transparent things such as glass is determined by *selective transmission.* Blue glass looks blue because it transmits mainly blue wavelengths. If illuminated by white light, blue wavelengths pass through the glass to your eye. The other wavelengths are either absorbed by the glass or reflected from its surface—back toward the source.

In general, the color of an object is determined *both* by the color of the light which illuminates it and the selective transmission or reflection of the object.

THE VISUAL COLOR OF FILTERS

If you hold a color filter between your eye and white light, you see the colors which are *transmitted* or passed by the filter. The effect of a filter on film is often more easily predicted by thinking about the colors the filter *stops* rather than those which get through.

Because human vision responds only to red, green and blue, it is only these three colors and their combinations that you have to worry about.

If a filter blocks all three primary colors completely, it looks black. If it only reduces light transmission but some light at each color still comes through, the filter appears gray.

If a filter blocks red, then it transmits both blue and green. To the eye, light coming through the filter appears bluish green—a color photographers call *cyan.* We say cyan is the complementary color to red because you get cyan if you block red but transmit blue and green. Each of the three primary colors has a complement, according to this table.

Primary Color	Complementary Color
Red	Cyan (Blue-Green)
Green	Magenta (Red-Blue)
Blue	Yellow (Red-Green)

In printing color films, laboratories use complementary-colored filters, so the words *cyan, magenta* and *yellow* are part of the language of photography and you should know what they mean.

ADAPTATIONS OF THE EYE

There are three kinds of human visual adaptation which are important in photography. One relates to the brightness of light. We can be visually comfortable in outdoor sunlight. On entering a building, we have the sensation that it is darker only for a few seconds and then we adapt to the lower level of illumination and don't notice it any more. On returning outdoors, we again adapt to the higher brightness in short time.

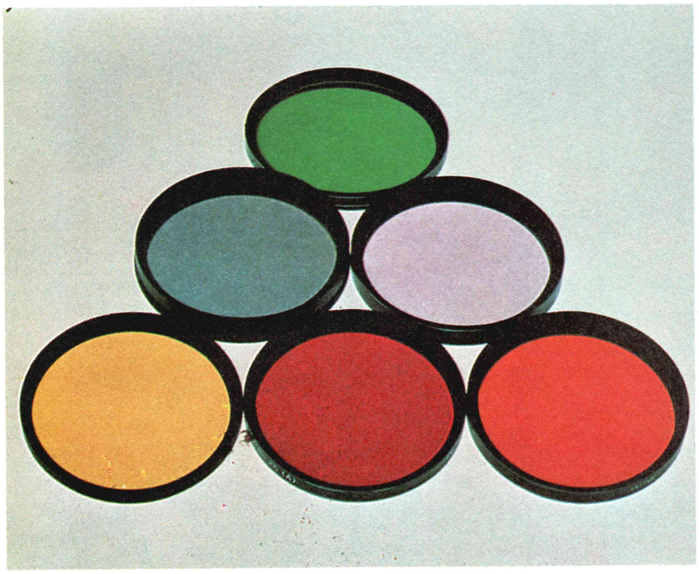
The result is, people are very poor judges of the amount of light and should rely on exposure meters which don't have this adaptability problem.

We also adapt to color of light in the same way. If you are reading at night, using a tungsten reading lamp, you adapt to the yellowish color and don't even notice it. The paper in this book looks white to your mind. Go outside and look at your window. It will be obvious that you are reading in light which has a definite yellow cast.

Another adaptation results from your feeling of *participation* in a real-life situation. This turns up in several ways which often make a photo look ridiculous.

You can pose somebody in front of a tree and think it's a fine shot. When you look at the print, a tree limb seems to be growing out of your model's ear which seems absurd in the picture, even though it didn't bother you at all when it was real life.

When you look at a person in side-lighting, half of the face is in deep shadow but you think nothing of it. You know the person has a complete face with the two sides similar to each other. Take the picture and it will look different. Without being there, you are not nearly so charitable and when looking at



Color filters change the color of light by transmitting some wavelengths and blocking others.

Atmospheric scattering of light is caused by the air itself, plus dust and smog. If the air is clean, haze looks blue. It gives a perspective effect in photographs, calling attention to the fact that distant objects are distant.

the picture you ask, "Where is the other side of that guy's face?"

You Have Just Been Un-adapted—Because these adaptations are largely in the mind, they can be altered or even reversed by a mental process called thinking. As soon as you know about the difference in color of tungsten light compared to daylight, you no longer fall victim to your visual adaptations. In that sense, you no longer have them.

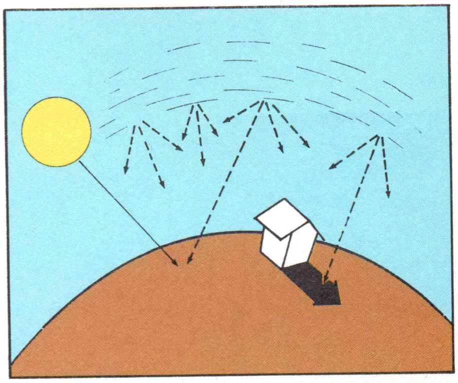
THE EFFECTS OF ATMOSPHERE

The sun flings energy toward the earth over an extremely wide spectrum, part of which is visible. The atmosphere acts as a *filter* to block transmission of some wavelengths and allow transmission of others, including all visible wavelengths.

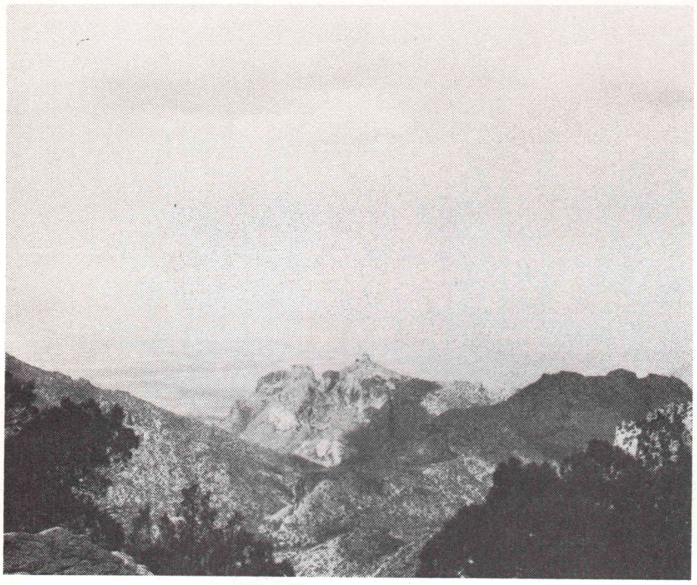
The atmosphere also has an effect on light rays which is called *scattering.* Instead of coming straight-arrow through the air, some light rays are diverted from the straight path and bounce around in the atmosphere. The last bounce, for light that reaches the earth, is toward the earth. This is light from the sky as opposed to light directly from the sun.

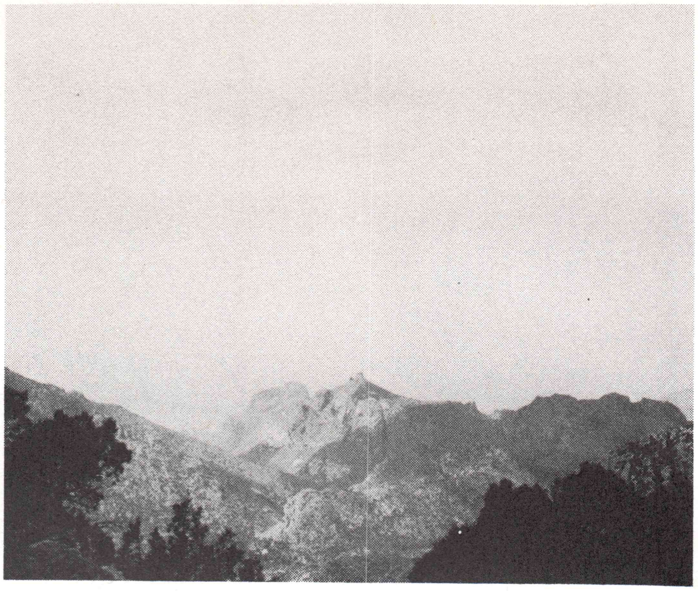
It happens that the atmosphere scatters short wavelengths much more than long wavelengths. Therefore blue light is extracted from the direct rays of the sun and scattered all over the sky. That's why the sky is blue.

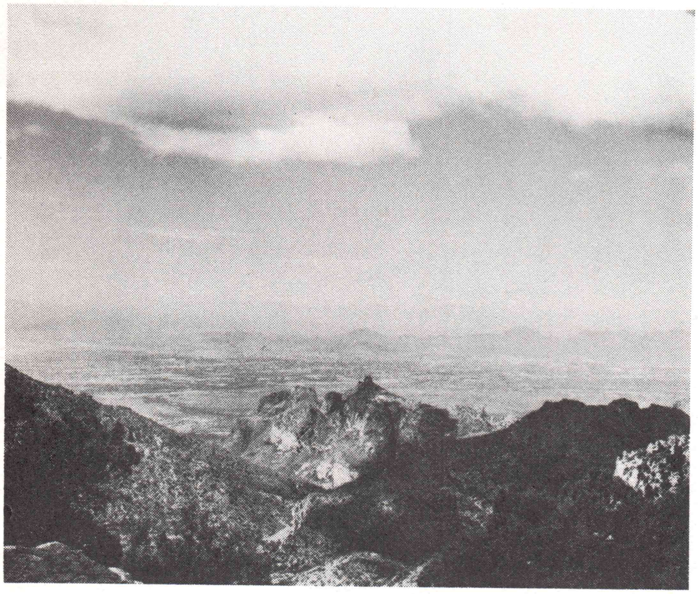
On a nice clear day, the sky is blue except near the horizon where it often looks white. This is another form of scattering caused by dust

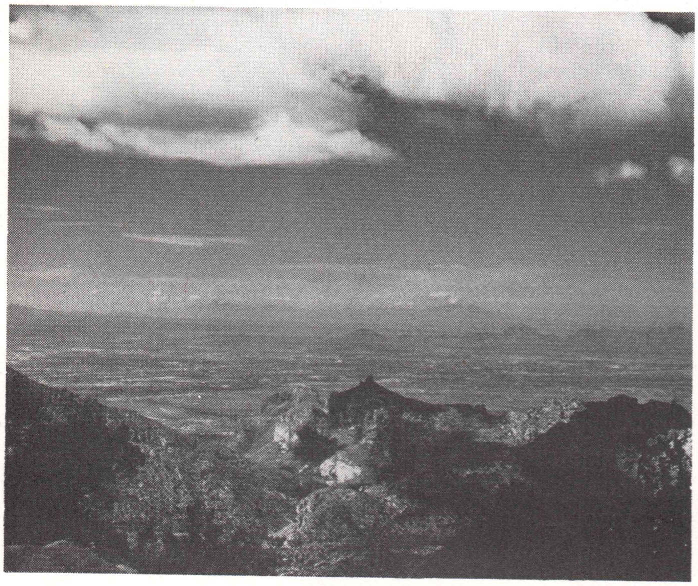


Atmospheric scattering extracts blue light waves from sunlight and scatters them all over the sky which makes the sky look blue. Without the blue component, sunlight looks more red-colored. At sunrise and sunset, sunlight travels through more atmosphere, more blue light is scattered, so morning and evening sunlight is more red-colored.









Top photo at left made with panchromatic b&w film and no filter. Distant valley is obscured by haze. You can see successive improvements in haze-cutting by a yellow filter, and, at bottom, a red filter. As filter color becomes more red, it excludes more of the scattered blue light.

Photo at right made with blue filter which transmits haze and blocks longer wavelengths which carry picture detail.

and smoke particles which are large enough to reflect most wavelengths of the visible spectrum. They scatter all of the light from the sun and the lower atmosphere appears to be white.

If you look from here over to that distant mountain, you are looking through a lot of lower atmosphere with both white-light scattering and blue-light scattering. The light rays coming to your eye from trees and rocks on the mountain are diverted from straight paths, details are obscured and the image looks hazy. We call that *atmospheric haze.* Fog is water droplets in the air and is worse than dust and smoke as a light scatterer and image obscurer.

The air itself scatters blue light and other particles in the air tend to scatter all colors of light. Therefore even from point to point in the lower atmosphere, blue light is scattered more than any other wavelength.

If you take a picture without using the blue light rays to expose the film, there will be less atmospheric haze in your picture. Details of a distant scene will be more distinct. You can do that by putting a color filter over the lens which excludes blue light. It must therefore pass both green and red light. If you hold such a filter against white light and look "through" it, it will look yellow, because the combination of red and green makes the sensation of yellow light.

It is common to use a yellow-colored filter over the lens to cut atmospheric haze. This works fine on b&w film, but on color film it will make a yellow-colored picture.

If your picture on b&w film is still too hazy with a yellow filter, remember that short wavelengths of light are scattered more than long wavelengths. If excluding short wavelength blue won't do the job, try also leaving out medium-wavelength greens. The filter now transmits red only, but image detail is greatly improved.

What if you exclude blue, green and also red? That will use still less scattered light to make the picture. A filter that excludes all three primary colors will look black because no visible wavelengths get through. Invisible IR wavelengths can come through a very dark-looking IR filter and expose IR film. That's the best haze cutter of them all.

Another effect of light scattering between your camera and the scene is reduced contrast of the image on the film. Light rays coming from bright parts of the scene are diverted by scattering so they land on the film at the wrong places. Some will land where it should be dark and that will make the dark places lighter.

You can see this when outdoors on a sunny day. Notice the contrast in brightness between sunlight and shadow near where you are. Then look as far away as you can and compare the brightness of sunlight and shadowed areas over there. The shadows will appear much lighter than those nearby—due to atmospheric scattering.

Any filter which blocks scattered rays will improve contrast and sharpness of the image on the film.

COLOR-SENSITIVITY OF B&W FILM

Even black-and-white film is color sensitive. The early b&w emulsions were sensitive mainly to blue and UV light. Photos of women with red lipstick caused the lipstick to appear black because the film did not respond to red.

An improved film, called *orthochromatic* was still deficient in red-response.

Current b&w films, called *panchromatic* are said to be responsive to all visible wavelengths and as a practical matter, they are. There is still a slight deficiency in red response and too much sensitivity to blue, but it is usually not noticeable.

COLOR FILTERS WITH B&W FILM

Because the result of exposing b&w film to light of various colors is always shades of gray between black and white, we tend to think b&w film is colorblind.

It is difficult to relate the color response of b&w film to human vision which notices both color and brightness. Technically, they are tied together by saying that the brightness of an object in b&w, even though it is gray, should correspond to the brightness of that object in the original scene as viewed by people, never mind what color it is.

I think it is more important to recognize the fact that the major problem of b&w film is just that—it records in shades of gray. The print does not show colors which help to distinguish a red apple from green leaves or a yellow skirt from a blue sweater. If the skirt and sweater happen to cause the same shade of gray on the film they will look the same in b&w.

Usually a b&w picture is improved if objects of different color record as different tones or shades of gray because the viewer of the print *expects* to see some difference between a necktie and jacket, or a rose and foliage.

You can use color filters on your camera to change brightness on a b&w print so there is a visual difference between adjacent objects of different colors, as you can see in the accompanying photos.

The rule when using color filters with b&w film is: *A filter lightens its own color.* This applies to the final print, not the negative, but it is the print you are concerned about. A corollary to the rule is: *A color filter used with b&w film darkens every color except its own.*

It is common with b&w film to use filters to make clouds stand out against a blue sky. With no filter, clouds in the sky are sometimes nearly invisible and the entire sky is light-colored in the print. It is much more dramatic to have a dark sky with white clouds.

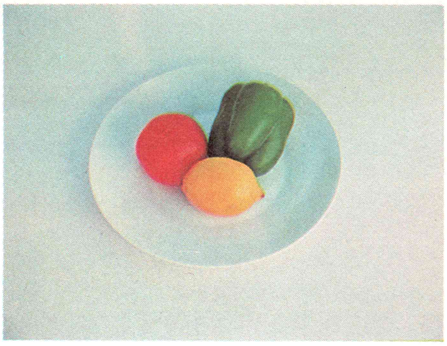
White clouds reflect all colors of light, but the sky is blue. Suppress blue with a filter and the sky darkens. The clouds darken too, but not as much. Because you are using b&w film, you can go as wild as you want with filter colors and only different shades of gray will result. The heirarchy of sky-darkening filters for b&w film runs from yellow to light red to dark red with more effect as you use darker reds.

Naturally the effect of a red filter appears on everything in the scene. If you include a model with red lipstick, the filter is an open door for red color and your model's lips will be lighter in tone.

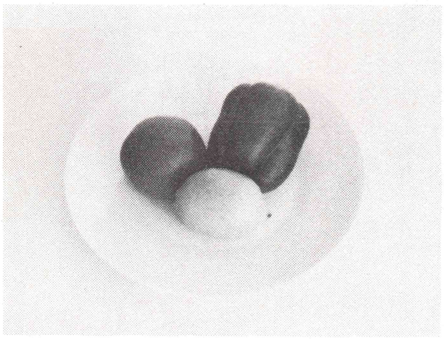
A compromise filter often used for outdoor b&w portraits is a shade of green. This suppresses blue to darken the sky some but also holds back red so makeup and skin tones are not affected so much as with a red filter.

HOW COLOR FILMS WORK

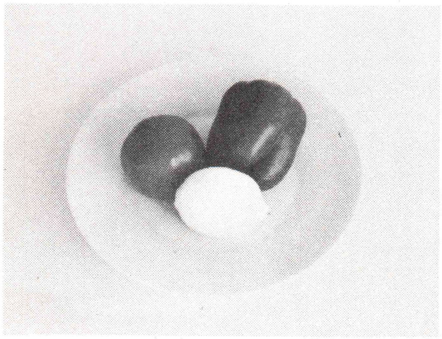
Color film and the color printing process used in books and magazines is possible only because human color vision is based on the three primary colors. A color picture needs to have only these three



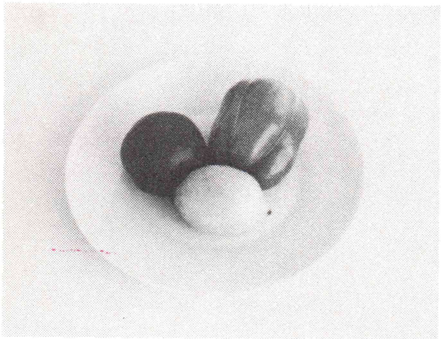
With color film objects are visually separated by different colors even though they may be the same brightness.



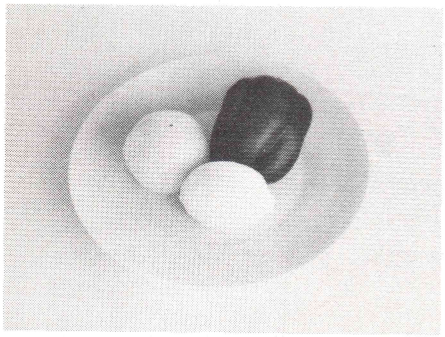
With black-and-white film, there are only shades of gray to distinguish one object from another. Without a filter, there's not much visual difference between a red tomato and a green pepper.



Used with b&w film, a color filter lightens its own color. Here a yellow filter was used. It lightened the lemon. Tomato and pepper are still distinguishable from one another mainly by shape.



Green filter blocks red light from tomato to make it appear darker. Slight lightening of pepper, not much effect on lemon.



Red filter lightens its own color and also lightens lemon because yellow wavelengths are close to red. Darkens pepper slightly. Use of color filters to improve contrast in b&w is generally predictable but sometimes there are surprises.

colors mixed in proper proportions to do a very good job of presenting all colors we can see.

Color film does this with three different layers of emulsion coated on a base. The main difference between a color slide and a color print is, the base of the print is opaque white paper.

The trick of color film is to use one layer to record the amount of each primary color—at every point in the scene. When viewing a color slide by transmitted light, or a print by reflected light, each layer controls the amount of light at its own primary color. The light we see from the combination of all three layers causes our vision to see the colors of the original scene.

Naturally the colors we see when viewing a slide or print are affected by the color of the light or room illumination where we are viewing the picture.

NEGATIVE-POSITIVE COLOR

Color prints are obtained from color negatives in a two-step procedure. A comparison to b&w will be useful. In b&w negatives, the shades of gray are reversed from the original scene. A white shirt appears black in the negative.

In color-negative film, after development, each layer transmits a reversed density of that particular color. If the subject is strongly red, the color-negative layer will be strongly not-red, meaning cyan colored. A color print made from the negative reverses the color densities again with the result that a strong red in the scene becomes a strong red on the print.

You have probably noticed an overall orange color of color negatives. Even the clear parts have an orange cast. The dyes used in color films are as good as each film manufacturer can make them, but not as good as the manufacturer would like them to be. These slight deficiencies in the color dyes are corrected by a complicated procedure called *color masking.* Evidence of masking is the orange color. It is removed when the print is made.

Because of color masking, the colors in a negative-positive process can be more true-to-life.

If a color print is made and the colors don't look quite right, it can be fixed by making another print. Color filters are used to change the color of the *printing* light and thereby make small corrections in color balance of the final print.

If you miss exposure a step or two when using color-negative film, it is usually possible to make a correction during printing, so the print is properly exposed and not too dark or too light.

Color-negative film allows the camera operator to make small mistakes, or be less precise about his work, and still end up with an acceptable print.

COLOR-SLIDE FILM

A color slide or transparency is the same piece of film you originally exposed in the camera. It is developed and chemically processed to make a positive image directly. This procedure is called *reversal* processing because it makes a positive out of a negative. There is no color masking because there is no opportunity to remove the orange color when making a print. The color balance of slide film is *theoretically* inferior to that of a good color negative-positive procedure but in practice, it's hard to see any problem with slide-film colors.

Because there is no separate printing step to make a color slide, there is no opportunity to correct a bad exposure and no way to change the color balance of the positive. This makes exposure more critical, both in the amount of light on the film and its color.

Color-slide film will often make a perfectly good image when under- or overexposed a small amount, but it won't *look right* when projected on a screen. It will be too light or too dark overall, particularly when viewed in succession with other sides which were properly exposed. For this reason, we say that color slides should be correctly exposed—within half a step either way.

When any color film—negative or reversal—is seriously over- or underexposed, two effects may result. One is comparable to over- or underexposing b&w film. Light areas become too light, or dark areas become too dark, and contrast is lost between portions of the scene in the too-light or too-dark area.

The second effect is peculiar to color film and is caused by reciprocity failure of the three layers, acting individually. Because the three layers are *different emulsions,* they usually don't go into reciprocity failure simultaneously and when they do, they don't react in exactly the same way.

A typical result of serious exposure error with color film is that one layer goes into reciprocity failure and needs more exposure but doesn't get it. Therefore that layer is effectively underexposed and does not properly control its color when developed. The end result is an overall color cast, such as pink or blue, which affects the entire picture.

This can be corrected in a negative-positive process if the color change is not too severe. But with color-slide film, you get what you shoot. Manufacturer's instructions for correcting reciprocity failure with color film usually call for *both* additional exposure *and* a color filter over the camera lens.

Making Tests—Whenever you are making tests of equipment or your skill, it's important to see what you actually put on the film. Most film laboratories will automatically make corrections when printing b&w or color negatives to compensate for apparent errors in exposure or color balance. If you are testing exposures and deliberately shoot some frames over- or underexposed, you don't want the lab to correct your shots.

Color-slide film is the best way to make tests. What you get is what you shot, without any corrections by the film lab.

FILTERS FOR COLOR FILM

First, you should know there are three types of color film. Two are made so they make a good color image with tungsten illumination.

If you use tungsten film in tungsten light, the manufacturer has already solved the problem for you and you don't have to use a filter to change the color balance of the light that gets on the film.

If there is not enough room light to shoot with, you can add light by using special photo lamps, commonly called Photofloods. There are two types. Photofloods which are unmarked for color temperature operate at 3,400 degrees to get more light output but with shorter life. Those marked 3,200 degrees operate at that temperature, which is closer to normal room lighting.

Type B tungsten film is intended for use with 3,200-degree lights. If you use 3,400-degree lamps with Type B film, you should use a filter over the camera lens.

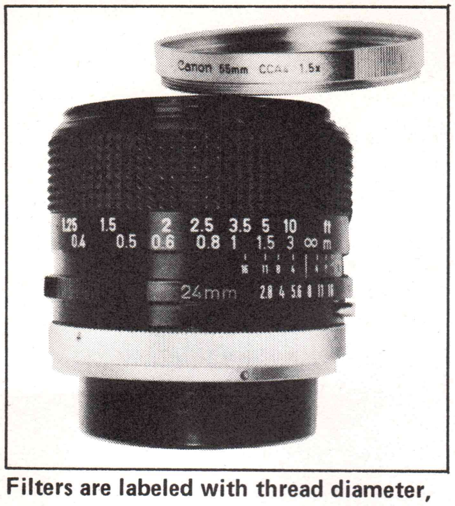
Type A color film is designed for use with 3,400-degree lighting. If you use it with 3,200-degree lamps or ordinary room lighting, you should use a filter over the camera lens to compensate.

The table on page 119 gives filter recommendations for various types of films and lighting.

Daylight color film is balanced for daylight, but you may need to use a filter anyway.

Ultra-violet light is reduced by the atmosphere but present in some amount everywhere. The higher you are in altitude, the more UV there is to expose your film. You can't see it and your exposure meter probably ignores it, but the film will be exposed by UV. There are *UV filters* which reduce transmission of UV. They are clear because they don't stop any visible wavelengths.

Even at sea level they are of benefit—partly because they protect the lens itself. In the mountains a UV filter should always be used. This applies equally to b&w



Filters are labeled with thread diameter, identification and filter factor. In this case the filter factor is 1.5X, meaning multiply exposure by 1.5 to compensate for light loss in the filter. If you use internal camera metering, disregard filter factors.

film because it is also sensitive to UV.

If atmospheric haze is a problem, you want to exclude short wavelengths. With color film, you can't use a strongly-colored filter unless you want the picture to have that color. *Haze filters* for color film cut UV and also cut some of the barely visible blue wavelengths—the shortest. A haze filter for use with color film is practically clear. If you use one, you don't need a UV filter because it will do both jobs.

A subject in shade outdoors is illuminated by skylight which has more blue in it than average daylight or direct sunlight. With color film, the effect is usually noticeable as an overall blue cast to the picture and bluish skin tones on people. *Skylight filters* for use with color film block some of the blue light to give a more warm-looking picture. Some photographers like the effect even in daylight or direct sunlight, so they put a skylight filter on the lens and use it all the time with color film outdoors. It also blocks UV.

There are filters which allow you to use indoor film in daylight, and daylight film indoors.

To use tungsten film in daylight, the filter has to alter daylight so it looks like tungsten to the film. The filter will reduce the amount of blue and green so what comes through has a color balance similar to tungsten light. Such filters have a yellow-orange appearance when viewed in white light.

To use daylight film indoors, it depends on what kind of illumination is being used inside the building. If it is tungsten light, the filter must change it so it appears to be daylight as far as the film is concerned.

The filter will block a lot of red and will look bluish or blue-green in white light.

If the indoor illumination is fluorescent lamps, it is difficult to filter. Some look bluish and some are designed to look like daylight to humans. Daylight fluorescent light sources do not look like daylight to film. Filter manufacturers offer one or more types of filters for use with fluorescent lighting and the best guide to their use is the maker's instructions.

I have done some experimenting with color filters for special effects with color film and enjoy doing it. I suggest you try it.

MIXED LIGHTING

A problem always results from using color film with more than one type of lighting. If you are photographing a person under room lighting but near a window which allows some daylight to fall on the model's face, what do you do? If you use tungsten film, the daylight will give a blue cast to skin. If you use daylight film, the skin will have a warmer tone. Most people greatly prefer warm tones to cold bluish tones, so the choice should be daylight film.

Mixed lighting is a problem solved best by avoiding it. If you must shoot with such light, experiment with different filters until you find something that is acceptable.

FILTER FACTORS

Most filters reduce light at visible wavelengths. They reduce it more at some wavelengths than others, but the net result is still less light on the film. This does not apply to visually-clear filters such as UV and some haze filters for color film.

Filter manufacturers normally state the amount of light loss as it affects the film exposure by a number known as the *filter factor*. This number is used to *multiply* the camera exposure that would be used without the filter—to get the correct exposure with the filter. The symbol X is included in a filter factor to remind us that it is used as a multiplier.

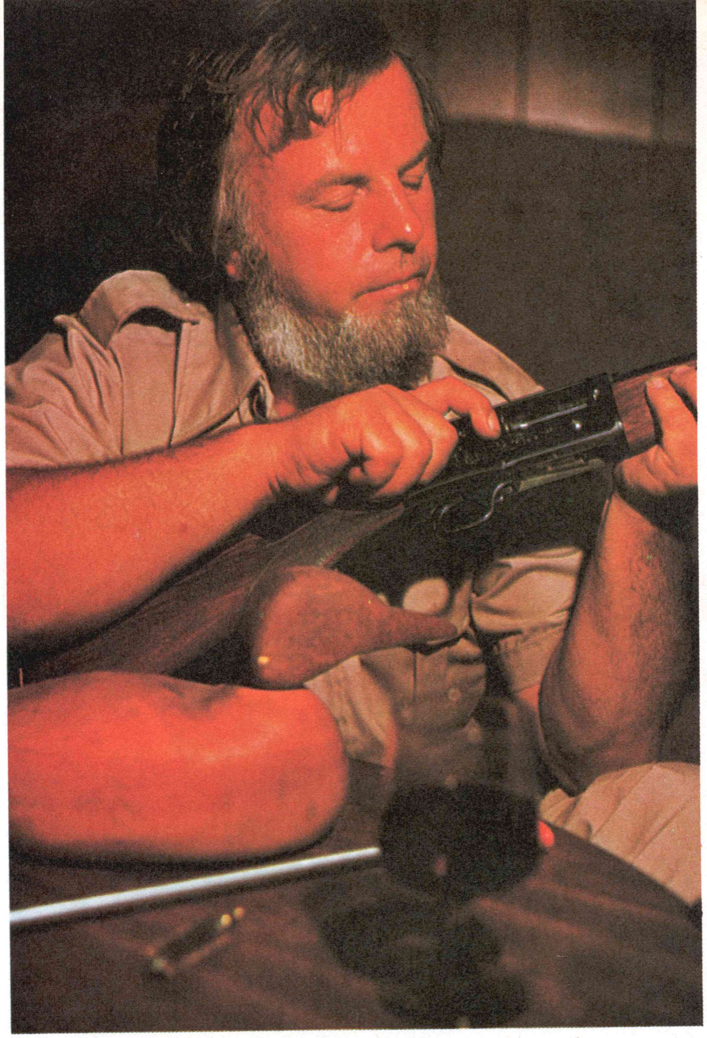
Some examples will clarify this. A 2X filter must be compensated by two times as much exposure which is one more exposure step. Use the next smaller *f*-number or the next longer shutter speed. A 4X filter requires two exposure steps. An 8X filter needs three exposure steps.

Canon cameras meter behind the lens and the camera exposure meter automatically compensates for the effect of a filter on the lens.

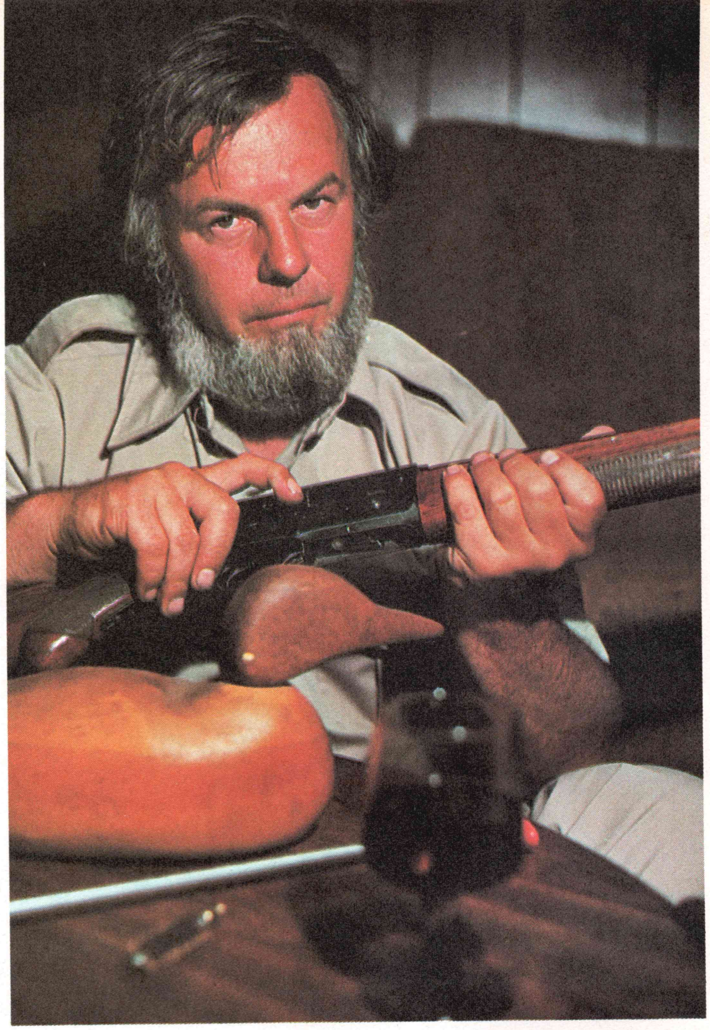
That is a great convenience. You can put on different filters and shoot quickly just by balancing the viewfinder display for exposure. You don't have to worry about filter factors or making exposure corrections for them.

You are not getting filtering free. Even though it is simple and uncomplicated to set exposure with a filter on the lens, the correction you make *must* have the effect of increasing aperture or exposure time.

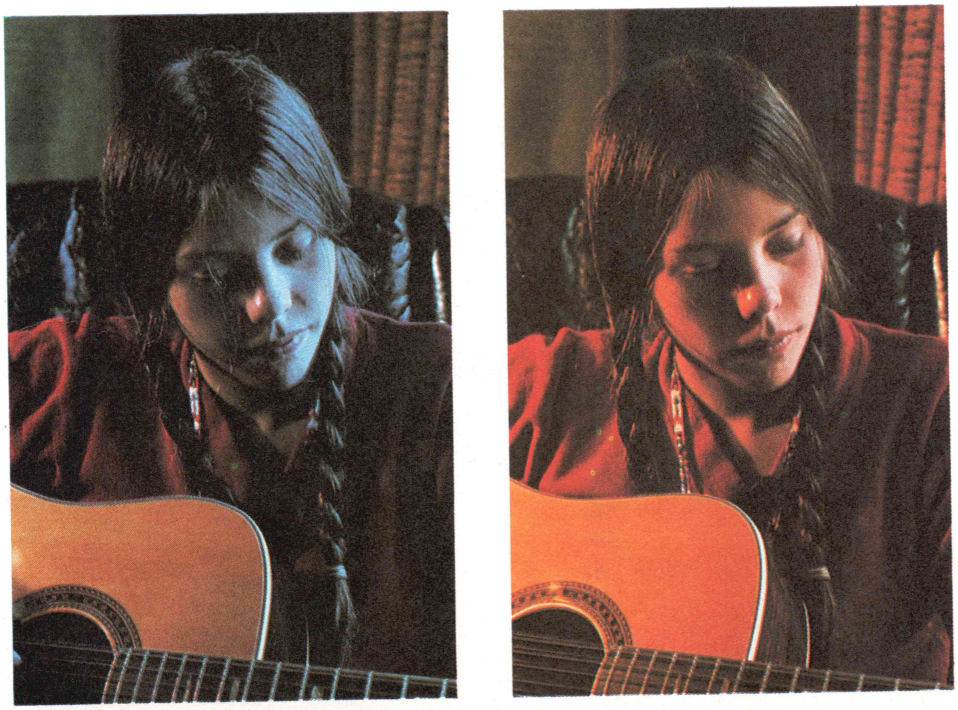
If you are shooting action in poor light and decide to pop on a red filter with a filter factor of 8X so the sky will be dramatic, you may also have a dramatic shooting problem called *you can't do it!* With action, you probably can't slow down the shutter by three steps. If you were already shooting in poor light, you probably can't open up by three *f*-stops and even



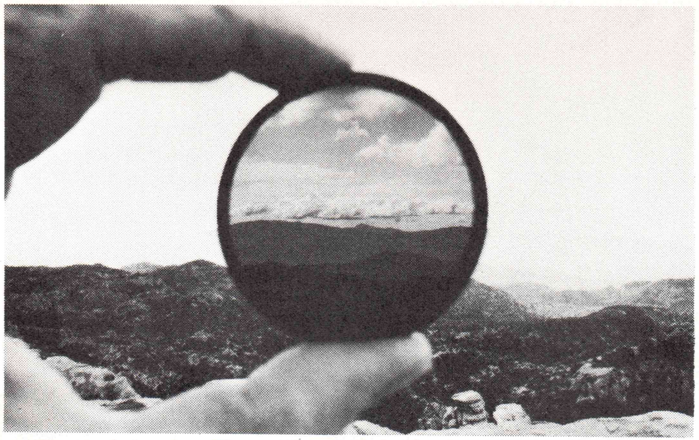
Using daylight slide film with tungsten lighting makes scene appear orange. This is often acceptable unless there are people in the picture.



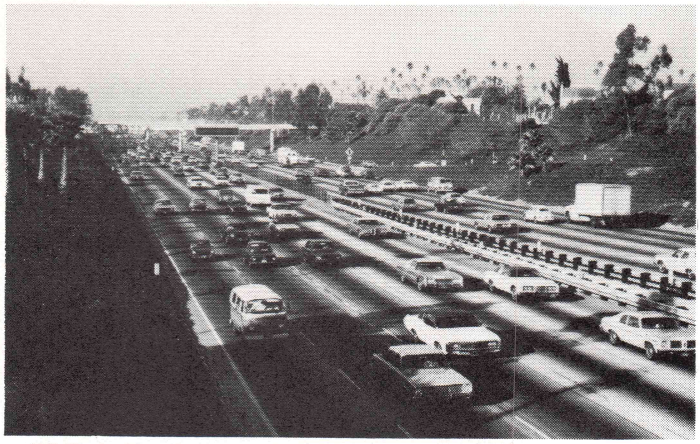
A light-conversion filter converts tungsten light to appear as daylight to daylight film by removing some of the red-orange. Skin tones improve.



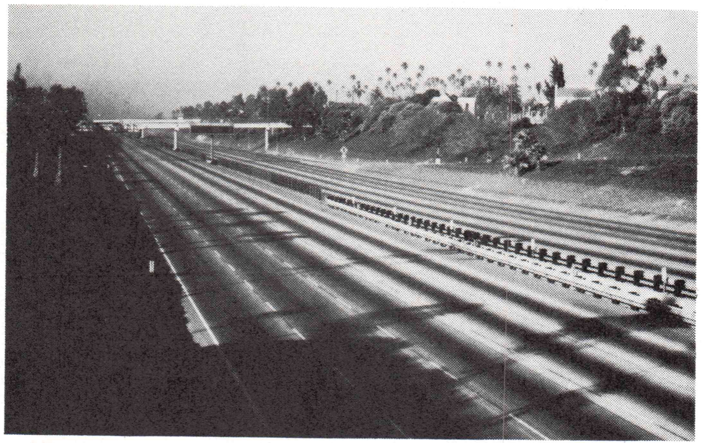
Subject by window receives mixed lighting—warm-looking tungsten on one side, cold-looking daylight on the other because this was shot with tungsten film. A light-conversion filter makes daylight look OK to tungsten film by removing some of the blue. This also warms the tungsten light but the overall result is better.



Neutral-density filter reduces light in the same proportion at all colors so does not affect color balance. It is not a haze-cutter even though this picture makes it appear so—it just changes exposure on the film. Notice reduced light makes terrain lose detail into black. It also brings distant hills and sky out of solid white on film, so different picture detail shows.



While in Los Angeles, Josh Young became vexed at the freeway traffic and decided to eliminate all other drivers. Notice tree shadows on cars.



His secret weapon was a Kodak Wratten gelatin neutral density filter with a *density* of 4.0 (not filter factor) which allowed multiplying exposure time by 10,000 plus additional exposure for reciprocity failure. Filter factor is 10,000. He solved reciprocity failure problem by series of arbitrary longer exposure times. No moving vehicle remained in the frame long enough to have visible effect on film. Tree shadows are still there. Don't vex Josh!

if you can, depth of field may disappear.

Filter factors are also a guide in purchasing a filter because they tell you how strong the color will be. Higher filter factors mean deeper colors and more light loss.

NEUTRAL-DENSITY FILTERS

There are circumstances when you want to get less light into the camera so you can expose for a longer time or use smaller aperture.

Gray-colored filters, called *neutral density* (ND) reduce the amount of transmitted light uniformly across the visible spectrum, which is why they are called *neutral.*

These filters can be used with either color or b&w film because they have uniform color response. Some people say because an ND filter only has the effect of taking out white light, it does not change the colors or color balance of the image. It depends on your point of view. If you look through an ND filter, all colors are different because they are less bright.

Some ND filters are rated the same way as color filters—by a filter factor. Commonly available ratings are 2X, 4X and 8X.

You may have to stack filters, meaning put one in front of another, to get the required density. When stacking filters using filter-factor ratings, the combined rating is obtained by *multiplying* the individual ratings. A 2X filter and an 8X filter used together have a rating of 16X.

Some ND filters are labeled with their optical density instead of a filter factor. The two ratings can be tied together by the fact that each increase in optical density of 0.3 is equal to a filter factor of 2X.

When filters rated by optical density are stacked, the densities add directly. An ND 0.3 filter plus an ND 0.3 filter make an ND 0.6 filter—with a filter factor of 4X.

Some technical filters are rated by optical transmittance, or the percentage of light transmitted through the filter. A transmittance of 100% implies no light loss at all.

One can strain the brain in this welter of different kinds of ratings, so I made this table to tie them all together.

Optical Density	Percent Transmission	Filter Factor	Equivalent *f*-Stops
0.1	80	1.25	1/3
0.2	63	1.5	2/3
0.3	50	2	1
0.6	25	4	2
0.9	12.5	8	3
1.0	10	10	3 1/3
1.2	6	16	4
1.6	3	32	5
1.9	1.5	64	6
2.0	1	100	6 2/3
3.0	0.1	1,000	10
4.0	0.01	10,000	13 1/3

You can use ND filters in ordinary photography when the film in the camera is too fast for the job at hand. If you have high-speed film already in the camera and you need to make a shot or two in bright sunlight, clip on an ND filter and effectively slow down the film.

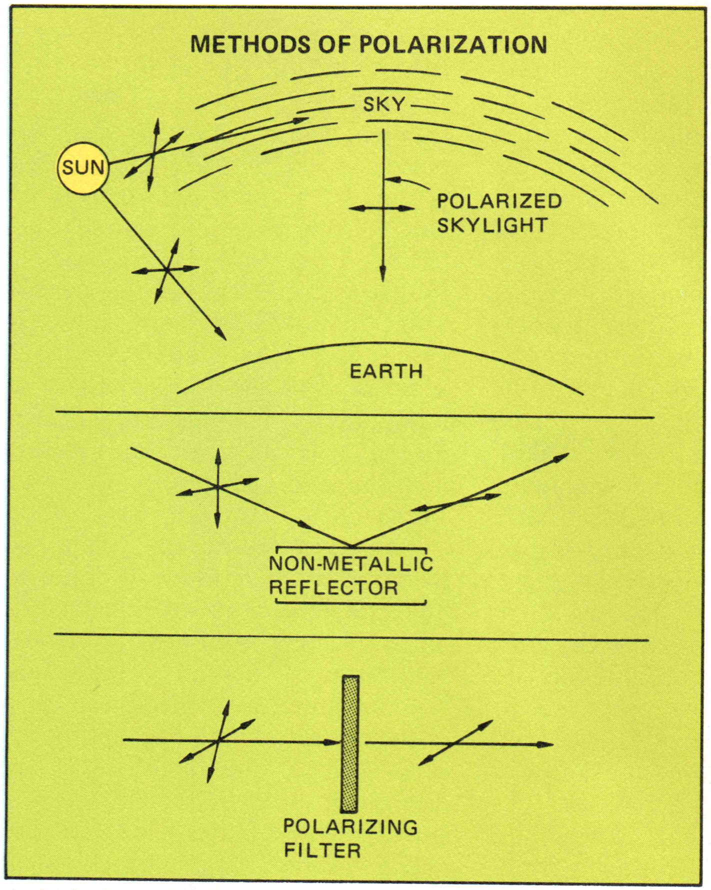
The camera will *behave* as though the film speed is divided by the filter factor. If you have ASA 400 film in the camera and put on an ND filter with a factor of 4X, you will end up setting aperture and shutter speed as if the film had a rating of ASA 100.

Does this mean you should change the film-speed dial of the camera from 400 to 100? No, even though some instructions seem to say that.

POLARIZING FILTERS

Still another property of light waves is responsible for *polarization,* the direction of movement or vibration of the light waves. Water waves again serve as a good analogy. Water particles in a water wave move up and down, so the wave is *vertically polarized.* Light can be vertically polarized, horizontally polarized, or polarized in all directions at once, is called *random polarization.* Direct sunlight is randomly polarized.

Some materials have the ability



Light from the sky is polarized when viewed at a right angle to the sun. In this drawing, crossed arrows indicate unpolarized light, single arrow perpendicular to ray path indicates polarized light. Light reflected from a non-metallic surface is polarized in the plane of the reflecting surface. Light passing through a polarizing filter emerges polarized, according to rotation angle of filter.

METERING THROUGH A POLARIZING FILTER WHEN USING F-1 or FTb—Canon recommends the following procedure for metering through a polarizing filter on a camera with semi-spot metering using an angled beam-splitter as in the F-1 and FTb.

1. Meter on a surface reflecting non-polarized light such as a wall reflecting sunshine at about 90°.

2. Rotate the polarizer so the meter needle drops to its lowest position. At this setting, what the polarizer is passing is partially blocked by the beam-splitter, so the metering error is maximum. Notice the rotational position of the polarizer and mark it if necessary.

3. Rotate the polarizer 45° in either direction. Make marks on polarizer and lens barrel so you can return to this setting. This is the "metering" position for the polarizer.

4. Meter the scene you intend to shoot with the polarizer set at the "metering" position. Set the exposure controls on the camera and don't change them before shooting.

5. Rotate the polarizer for desired effect and make the picture.

to transmit waves with only a single direction of polarization. These materials are made into *polarizing filters,* sometimes called *polarizing screens.* A polarizing filter that transmits vertically polarized light will not transmit horizontally polarized light, and the reverse.

If randomly-polarized light arrives at a polarizing filter oriented to pass vertical polarization, the horizontally polarized component will be blocked by the filter. If the filter were perfect, this would block exactly half of the total light in a randomly-polarized beam and the filter would have a filter factor of 2X or a density of 0.3. Practical filters vary from around 2.5X to 4X. They don't block all light of the wrong polarization, but the filter material is gray-colored so it also absorbs some light of all polarizations just because of the gray color.

Unpolarized light becomes polarized by reflection from smooth surfaces—except unpainted metal. Where such reflections occur, we see the reflection as glare, such as in a store window or glass display case, and on the surface of varnished wood furniture. When a polarizing filter is used to block such reflections the improvement is sometimes dramatic.

When unpolarized light is reflected from a surface, vibrations in the light which are parallel to the surface are reflected and those which are perpendicular are suppressed. For example, unpolarized light reflecting from a horizontal surface will become polarized horizontally. Please notice that the effect of reflection is merely to suppress light polarized in one direction and not suppress it in the other.

Canon warns users of camera models with semi-spot metering—F-1 and FTb—that exposure metering with a polarizing filter over the lens may not be accurate.

The reason is technically complicated but relates to the inclined beam splitter in the condenser lens which reflects part of the light over to the light-measuring sensor. This reflection tends to suppress light which is vertically polarized as it enters the camera. If you are using a polarizing filter which suppresses horizontally-polarized light from the scene and the beam splitter also suppresses vertically-polarized light from the scene, the light meter will "see" significantly less light than is really there. The camera exposure display will call for more exposure and the end result is overexposed film.

Polarizers are normally supplied in mounts which allow the filter to be rotated so you can change the angle of polarization while viewing the result. A metering procedure recommended by some Canon users is to set the polarizer for minimum effect, meter and set the camera exposure controls, then rotate the polarizer for the desired effect and shoot without changing the camera controls.

I use a polarizing filter often on Canon equipment and recommend you do the same. If you encounter a situation where you get a bad exposure, at least you'll know why.

A polarizer is the only way to darken blue skies to make the clouds stand out when using color film. The scattered blue light from the sky is polarized and the effect is maximum when viewed at a right-angle to the sun. When you rotate the polarizer so it suppresses the polarized blue light, the sky becomes darker and white clouds become highly visible.

Some manufacturers offer a special double polarizer which serves two purposes or you can make one by using two polarizing filters stacked so each can be rotated independently of the other. If both are set for the same angle of polarization, the effect is slightly stronger than with a single filter. If they are set so their angles of polarization are at right angles, they tend to block all of the light.

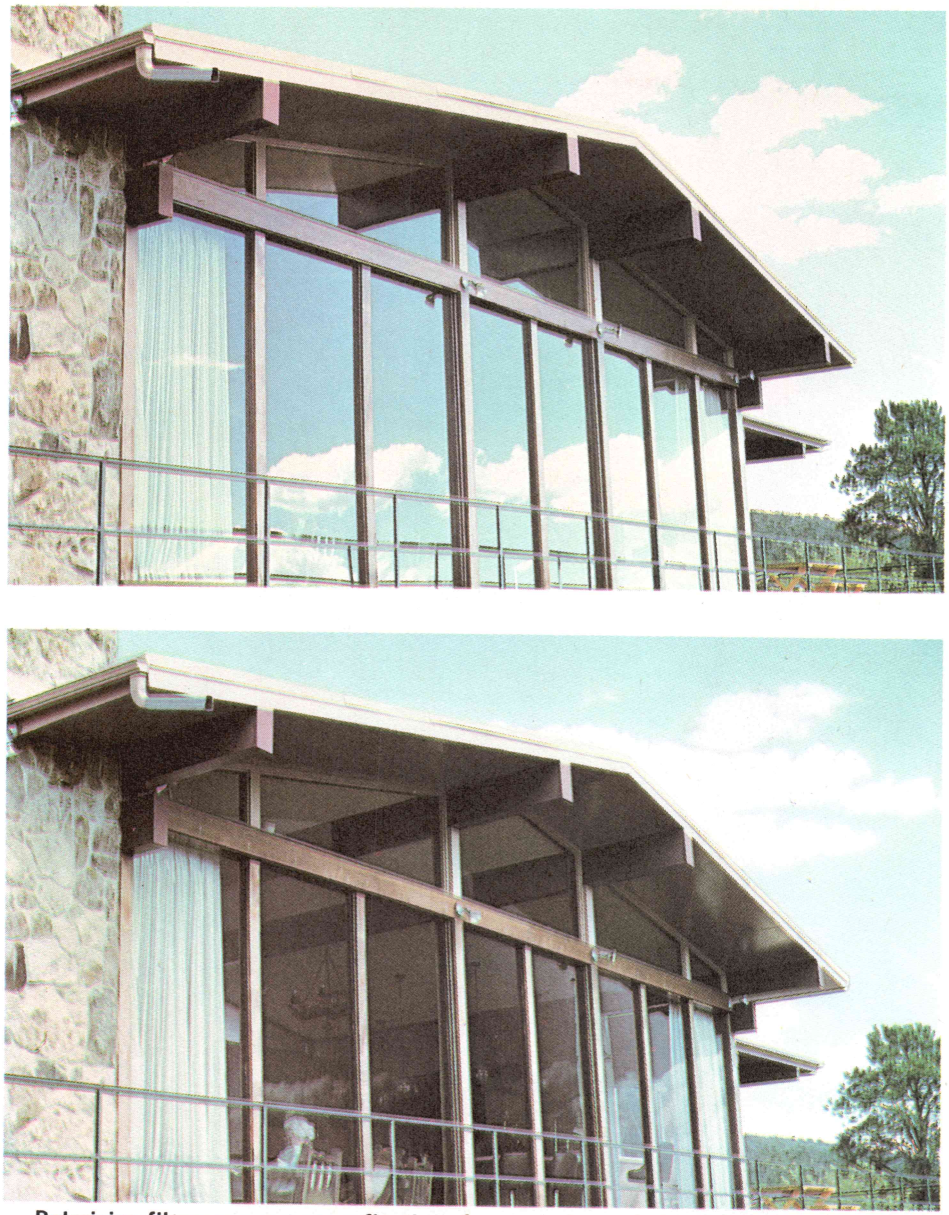
By rotating one of the two polarizers, this device acts as a variable neutral-density filter and the light passing through can be controlled from near zero to a maximum represented by a filter factor of around 3X to 4X, depending on the filters used.

Filters of different thread diameter than the lens can be used with step-up or step-down rings between filter and lens. Here a 55 to 52mm step-down ring is used to mount a 52mm filter on a lens with 55mm threads. When using smaller filters than normal size, image may vignette, particularly with wide-angle lenses.

FILTER MOUNTING

There are about as many ways to mount filters on cameras as human ingenuity can achieve. Canon uses the screw-type filter which screws into the threaded accessory-mounting ring on the front of most lense's. Each filter repeats the lens thread on the outer edge of the filter, so a second filter can be screwed into the first. As many filters as desired can be stacked by screwing them into one another.

A problem results from lenses with different screw thread diameters at the front. If you have a filter which fits a small-diameter lens, it will be too small for larger-diameter lenses and you may end up buying the same filter type in two diameters.



Polarizing filters can remove reflections from windows, darken blue skies without affecting other colors. Notice that the polarizer angle which darkens blue sky is not the same as the angle which removes reflection from glass windows.

With screw-in filters, the lens-size problem can be solved by purchasing filters to fit the lens of largest diameter in your set. Adapter rings are available at most camera shops which mount a large filter on a smaller lens. These are usually called *step-up rings.* The *step-down* type adapts a smaller filter on a larger lens which may cause vignetting of the image by blocking some of the light around the edges of the frame. Using a filter larger than the lens rarely causes any problem unless several are stacked.

Most Canon lenses use 55mm or 58mm filters. Exceptions are the very short focal lengths, some of which have built-in filters, the very long focal lengths, and the FLM 100mm Macro.

IMAGE DEGRADATION DUE TO FILTERS

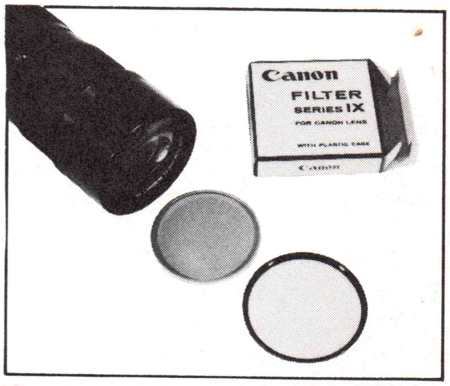
Besides vignetting due to stacking filters, image quality may deteriorate when several filters are used together. The image will normally show no visible effect from a single filter—except the desired effect. You can normally use two without worrying. When using three or more, test first to be sure you don't have problems with an important shot.

The light reflects back and forth between glass surfaces of a stack of filters, just the same as in a lens. Most good-quality modern filters are coated to reduce reflections.

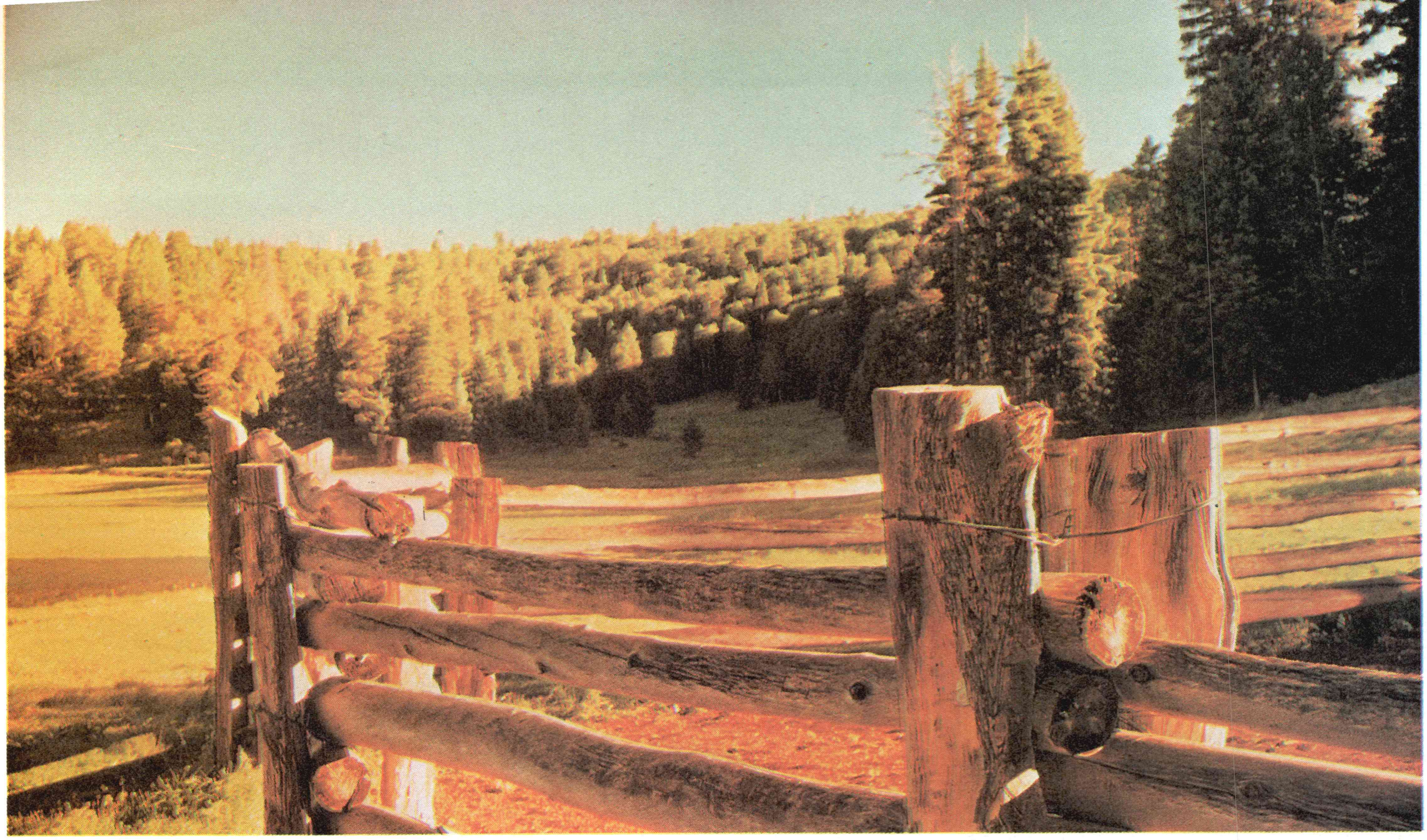
Filters have least effect on the image when they are mounted close to the front of the lens. Stacking and use of step-up rings puts some of the glass far enough from the lens to make aberrations and defects more apparent.

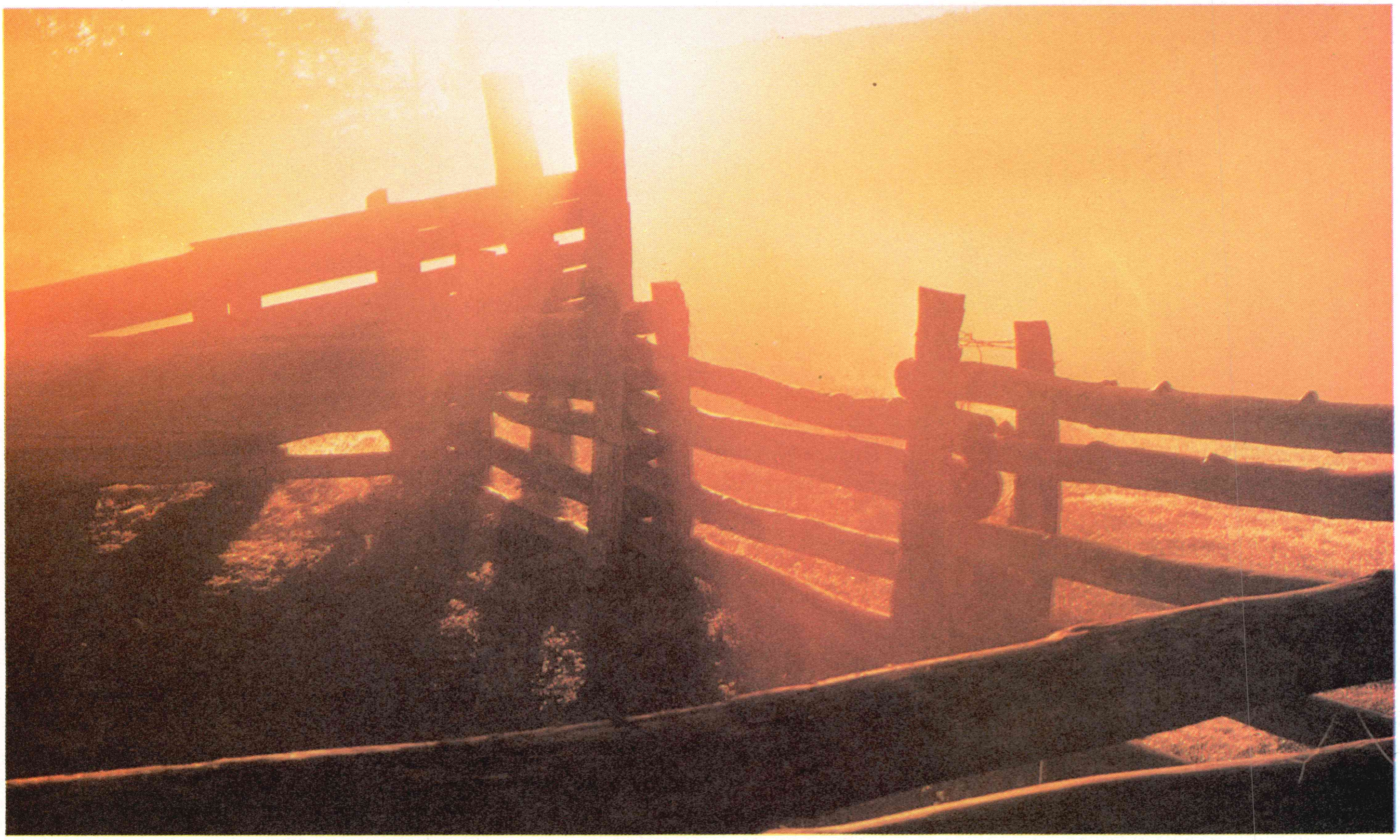
Naturally dirt, scratches or fingerprints on a filter surface will scatter the light and reduce contrast of the image, the same as dirt does on the lens itself. Filters should receive the same care as lenses.

Filters may fade with age, particularly if exposed to bright light a lot of the time. This change is hard to detect because it is gradual, but it may not be important until you can detect it.



Most Canon lenses use screw-in filters. Some have built-in filters. Some use Series filters. This 85-300mm zoom uses Series IX filters mounted in unthreaded metal ring. Filter drops into front of lens, held in place by threaded retaining ring.





Filters can serve more than one purpose. Photo of corral taken with daylight film in early-morning sunlight, didn't amount to much. A minute or two later, using an orange 85-B filter and shooting into the sun, I got a golden sunrise even if I had to help it a little. The "official" purpose of an 85-B filter is to shoot tungsten film outdoors.

Canon FILTERS

Filter*	Film Type	Lighting	*f*-Stop Increase	Suggested Uses
Sky 1A (Skylight)	Daylight	Daylight	None	Use outdoors to reduce blue in shade areas. Good protection for lens.
Haze (UV-1)	Daylight	Daylight	None	Reduces excess blue in haze, marine, and mountain scenes.
Yellow 2 (#8) (Y3)	B&W	Daylight	1	Used with Black and White films for better tone separation in sky, foreground and overall contrast. Can be used for monochromatic effects with color films.
Green 11 (G1)	B&W	Daylight	2	Used with Black and White Pan films—ideal for outdoor portraits against sky. Renders good tone separation in foliage and natural sky appearance. Can be used for special night effects with Infra-Red color film.
Orange 15 (O)	B&W	Daylight	1-2/3	Use with all Black and White films. Ideal for portraits of people with poor complexions when using Pan films. Excellent for greater contrast in copy work.
Red 25A (R)	B&W	Daylight	3	Heavy contrast effects for architectural subjects with pan film, used with black and white Infra-Red film for high contrast results. Excellent for cutting through aerial haze.
80A	Daylight	3200°K floods	2	Conversion of daylight color films to 3200° Kelvin light.
80B (CCB12)	Daylight	3400°K floods	1-2/3	Conversion of daylight color films to 3400° Kelvin light.
81A	Type B and Daylight	Electronic flash	1/3	Use with daylight color films to balance and reduce excessive blue from electronic flash. Use outdoors to prevent excessive blue in open shade and for added warmth. Corrects type B films for use with 3400°K light.
81B	Type B and Daylight	Electronic flash	1/3	For increased correction of the bluish cast caused by electronic flash units. Renders warmer results than the 81A filter.
85 (CCA12)	Type A	Daylight	2/3	Converts Type A color films for daylight use. Used with Daylight color films, produces vibrant sunsets and adds warmth to fall-foliage scenes.
85B	Type B	Daylight	2/3	Converts Type B color films for outdoor daylight use. Also renders warmer effects than the #85 filter.
FCB	Type B Films	All Fluorescent lighting	1	Use with Type B color films to correct yellowish-green cast caused by fluorescent lighting.
FCD	Daylight	All Fluorescent lighting	1	Use with all Daylight color films to correct the blue-green cast caused by fluorescent lighting.
ND 0.3	Color or B&W	All light sources	1	Use with all films for uniform reduction of light. Ideal for control of high-speed films by reducing the intensity of the light transmitted without changing the color-quality of the light.
ND 0.6 (ND-4)	Color or B&W	All light sources	2	Same as above. Allows 25% light transmission.
POLARIZER	Color or B&W	All light sources	2	Use for better color saturation, greater contrast between clouds and sky and for haze penetration. Eliminates surface reflections, unwanted glare. Can be used in combination with other filters for special effects.
(CCA4)	Daylight	Daylight	1-1/2	Warmer color in cloudy or rainy weather, or in shade.
(CCB4)	Daylight	Daylight	1-1/2	Reduce red color when shooting daylight film in early morning or late afternoon.

CAUTION: When using the POLARIZER filter on the Canon FTb or F-1 cameras: Take an exposure reading without the filter. Increase exposure by 2 *f*-stops or the equivalent change in shutter speed. Install filter and rotate for desired effect. Shoot without changing exposure controls.

All exposure increases are suggestions and may be approximate.

*Filter nomenclature not in parentheses is currently used in the USA. Nomenclature in parentheses was formerly used in USA and is still used in other parts of the world. Nomenclature in parentheses designates similar filters where both identifications are used, but not necessarily identical.

SOME 35mm FILMS

FILM TYPE	ASA Speed/Conversion Filter		
	Daylight	Tungsten 3400K	Tungsten 3200K
COLOR SLIDE FILM			
Kodachrome 25	24/none	8/80B	6/80A
Kodachrome 64	64/none	20/80B	16/80A
Kodachrome II Professional Type A	25/85	40/none	32/82A
Ektachrome 64 Daylight (ER)	64/none	20/80B	16/80A
Ektachrome 200 Daylight (ED)	200/none	64/80B	50/80A
Ektachrome 160 Tungsten (ET)	100/85B	125/81A	160/none
Ektachrome 400 Daylight (EL)	400/none	125/80B	100/80A
Agfachrome 64	64/none	20/80B	16/80A
Fujichrome R 100	100/none		32/80A

FILM TYPE	ASA Speed/Conversion Filter		
	Daylight	Tungsten 3400K	Tungsten 3200K
COLOR NEGATIVE FILM			
Kodacolor II	100/none	32/80B	25/80A
Kodacolor 400 (CG)	400/none	125/80B	100/80A
Kodak Vericolor II Professional, Type S	100/none	32/80B	25/80A
3M Color Print Film	80/none	25/80B	20/80A
Fujicolor F-II	100/none		32/80A
Fujicolor F-II 400	400/none		125/80A
BLACK & WHITE			
Kodak Panatomic-X	32	32	32
Kodak Plus-X	125	125	125
Kodak Tri-X	400	400	400
Ilford PAN F	50	50	50
Ilford FP4	125	125	125
Ilford HP4	400	400	400

TYPICAL EXPOSURE INCREASE FOR RECIPROCITY FAILURE OF KODAK BLACK & WHITE FILMS

	IF INDICATED EXPOSURE TIME IS:	USE ONE OF THESE CORRECTIONS (NOT BOTH)		AND CHANGE DEVELOPING TIME:
		Increase Aperture	Exposure Time	
	1/100,000	1 stop	Use Aperture Change	20% more
Panatomic-X	1/10,000	1/2 stop	Use Aperture Change	15% more
Plus-X	1/1,000	None	None	10% more
Tri-X	1/100	None	None	None
	1/10	None	None	None
	1	1 stop	2 seconds	10% less
	10	2 stops	50 seconds	20% less
	100	3 stops	1200 seconds	30% less

SPEED OF COLOR FILMS

As shown in the list of films at the top of this page, it is customary to publish different film speeds for color film used with light-conversion filters. The *true* ASA film speed is the highest of those given in the table and is the one with no filter. The reduced film speeds are for use with a *separate* exposure meter. Dialing the reduced speeds into an accessory exposure meter yields exposure settings for the camera which can be used directly without application of a filter factor. In other words, stating a different film speed for a film used with a conversion filter is simply another way of stating the filter factor.

With SLR cameras, when using through-the-lens metering, we do not use published film speeds adjusted downward for a light-conversion filter. Always set the true ASA film speed into your camera, whether you are using a filter or not. The exception is when you change film speed to under- or overexpose.

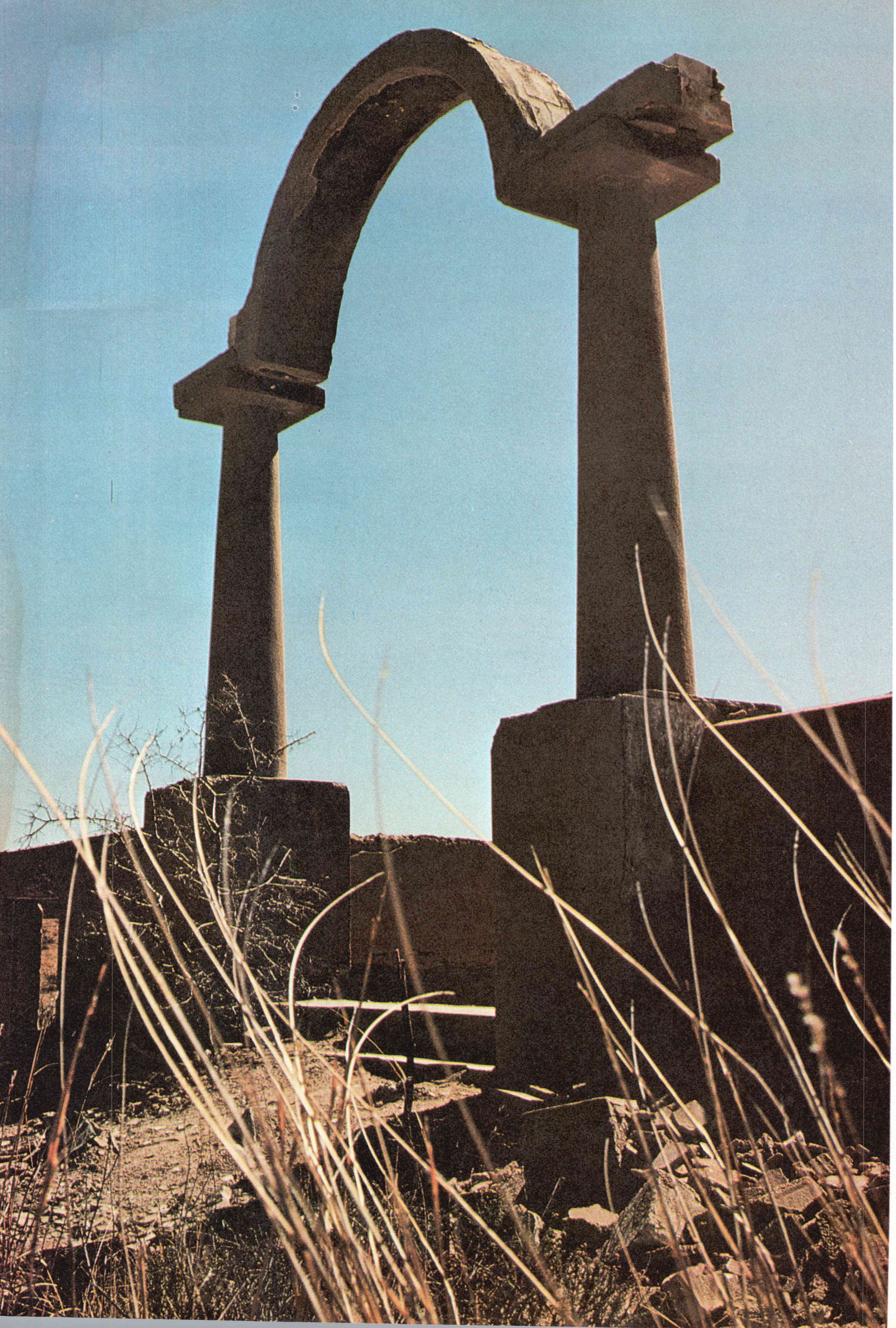
TYPICAL EXPOSURE INCREASE AND FILTERING TO CORRECT RECIPROCITY FAILURE IN COLOR FILMS

FILM TYPE	INDICATED EXPOSURE TIME (Seconds)										
	1/50,000	1/25,000	1/10,000	1/1000	1/10	1/2	1	2	10	64	100
Kodachrome II Professional Type A	†			None No Filter	1/2 Stop No Filter		1/2 Stop No Filter		1 Stop CC10Y		NR*
Ektachrome 64 (Daylight)			1/2 Stop No Filter	None No Filter	None No Filter		1/2 Stop CC15B		1 Stop CC20B		NR
Ektachrome 200 (Daylight)			1/2 Stop No Filter	None No Filter	None No Filter		1/2 Stop CC10R		NR		NR
Ektachrome 160 (Tungsten)				None No Filter	None No Filter		1/2 Stop CC10R		1 Stop CC15R		NR
Ektachrome 400 (Daylight)			None No Filter	None No Filter	None No Filter		1 Stop No Filter		1-1/2 Stop CC10C		2-1/2 Stop CC10C
Kodachrome 25			None No Filter	None No Filter	None No Filter		1 Stop CC10M		1-1/2 Stop CC10M		2-1/2 Stop CC10M
Kodachrome 64			None No Filter	None No Filter	None No Filter		1 Stop CC10R		NR	NR	NR
Fujichrome R-100				None No Filter		None No Filter	1/3 Stop CC5C	2/3 Stop CC5C	2/3 Stop CC10C	1-2/3 Stop CC20C	2 Stop CC20C
Kodacolor II	1 Stop CC20B	1/2 Stop CC10B		None No Filter	None No Filter		1/2 Stop No Filter		1-1/2 Stop CC10C		2-1/2 Stop CC10C + 10G
Kodacolor 400			None No Filter	None No Filter	None No Filter		1/2 Stop No Filter		1 Stop No Filter		2 Stop No Filter
Vericolor II Professional Type S			None No Filter	None No Filter	None No Filter		NR		NR		NR
Fujicolor F-11				None No Filter		None No Filter	1/3 Stop No Filter	2/3 Stop No Filter	1 Stop No Filter	1-1/3 Stop No Filter	1-2/3 Stop No Filter
Fujicolor F-11 400				None No Filter	None No Filter		1 Stop No Filter		2 Stop No Filter		3 Stop No Filter

* NR—Not Recommended

† Blank spaces indicate data not published by manufacturer where blank is *between* published data, estimate correction.

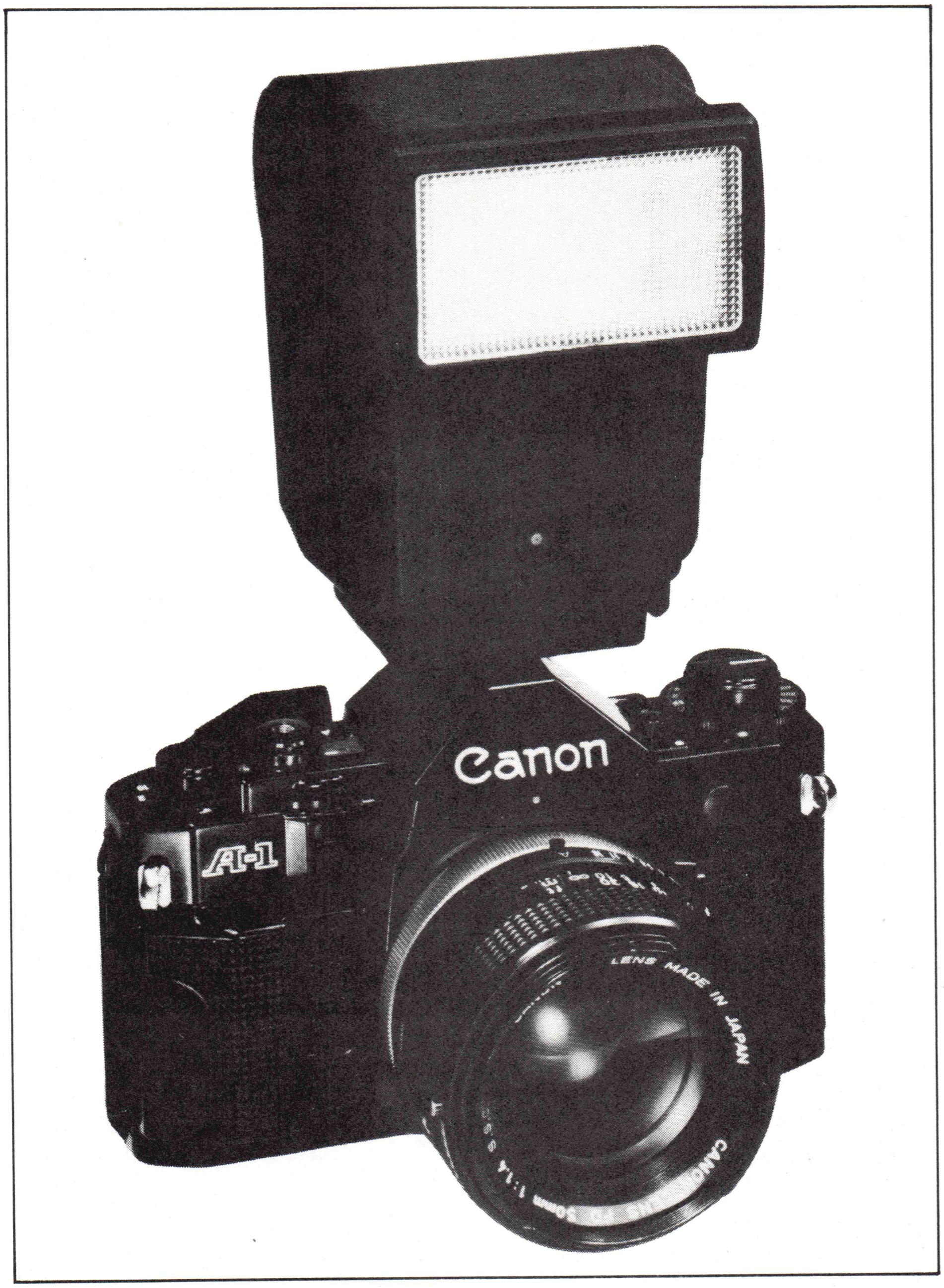
All data subject to change by film manufacturer.



This is a scene where background will fool the exposure meter. Exposure taken on foreground, then camera moved up to make the picture.

16

HOW TO USE FLASH



Flash units can make a direct electrical connection with the firing contacts in the camera by installing the flash into the hot shoe on top of the camera. Flash units without provision to use the hot shoe may be connected with a cord plugged into the flash socket on the camera body. This is the Canon 199A flash on an A-1 camera.

Flash bulbs superceded the old-fashioned pile of flash powder which the photographer held aloft and burned to make a bright light. In the same way, electronic flash units have replaced flash bulbs as the choice of most photographers using SLR cameras.

FLASH BULBS

Flash bulbs come in various sizes and types. All work by burning metal foil in an oxygen atmosphere within the glass bulb. Because the light is caused by combustion inside the glass envelope, light intensity increases from zero as combustion begins. It reaches a peak value and then falls off as combustion ends.

With some focal-plane shutters intended for use with flashbulbs, a switch, or pair of *contacts,* in the shutter closes the flash-firing circuit before the shutter starts to open. This allows a time delay during which the bulb comes up to full or near-full brightness.

Flash bulbs are plugged into a holder with a reflector behind the bulb so most of the light is directed toward the subject. One type has a connector cord which is plugged into the flash-sync connector on the camera body. These cords are called *PC cords* and the socket on the camera body is called the PC terminal.

Another type of flash bulb holder, such as the Canon Flash V-3, mounts directly on the camera into a bracket called a *hot shoe.* An electrical terminal in the hot shoe makes contact with a terminal in the base of the flash gun to make the electrical circuit which fires the flash. That's why it is called a *hot* shoe. Flash-bulb holders intended for use in a hot shoe require no other electrical connection except the one in the hot shoe.

ELECTRONIC FLASH

Electronic flash requires a high voltage, usually obtained from batteries through a voltage-multiplying circuit.

The gas used in electronic flash bulbs is xenon which produces a color temperature of around 6,000 degrees Kelvin. They are generally considered to have the same photographic effect as daylight.

Electronic-flash units fire virtually instanteously and reach full brightness immediately. Therefore no time delay is required. In fact, if there is a time delay, the electronic flash may be all over before the shutter gets open. To fire electronic flash with a focal-plane shutter, the flash contacts in the camera are closed at the instant the first curtain of the focal-plane shutter reaches fully open—called X *synchronization.*

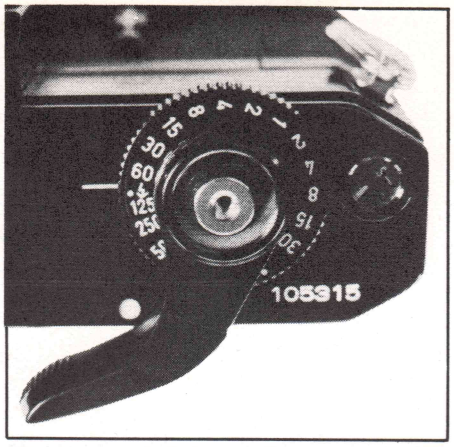
Electronic-flash units are available which mount on the hot shoe and are triggered by the electrical contact in the shoe. Other types use a PC cord which connects to the PC terminal on the camera.

HOW DOES THE CAMERA KNOW WHICH TYPE OF FLASH YOU ARE USING?

You can use bulb-type or electronic flash with any Canon SLR, with certain restrictions. The F-1, FTb, TX and TLb operate as follows:

The camera "knows" which type of flash you are using by "noticing" which shutter speed you have selected. If you set the shutter at the speed required for electronic flash—as discussed on page 126—the camera operates on X sync and has no delay. If you operate at other speeds, the camera provides a built-in delay suitable for some *but not all* flash bulbs.

Different flash bulbs require different amounts of delay, however Canon cameras offer only one standard amount of delay for bulb flash—suitable for most purposes. Therefore you can't use all types of flash bulbs and all shutter speeds. In the instruction booklets for each camera, and also in Chapter 18, are tables which show suitable flash bulb and shutter-speed combinations.



Shutter-speed dial must be set at correct sync speed for use with electronic flash. Arrow symbol identifies proper setting—1/125 or 1/60 depending on camera model. Canon 199A and 155A flash units set shutter speed automatically on A-series cameras.

A-series cameras and the EF offer X sync only, but there are some combinations of flash bulb and shutter speed that work OK when fired with no delay. These require shutter speeds of 1/15 second or slower.

HOW A NON-AUTOMATIC ELECTRONIC FLASH WORKS

You don't have to be an electronic whiz to understand the basic operation of an electronic flash. Figure 16-1 shows a power source feeding a voltage converter. The power source is usually batteries, but for some equipment it is AC power from a wall socket.

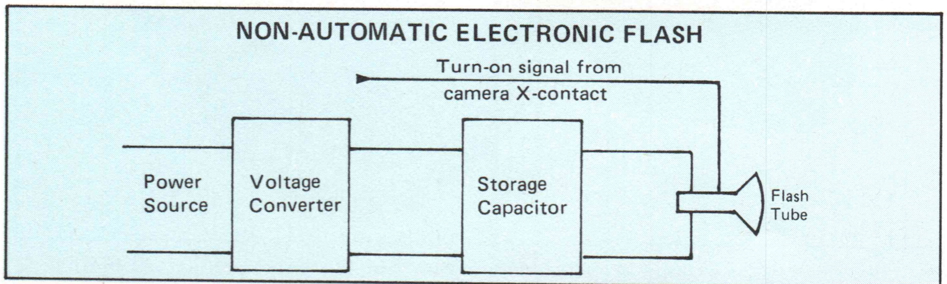
Either way, the electrical voltage to operate the flash tube is higher than the supply or source voltage so a special circuit converts it to a higher voltage. This high voltage is accumulated in a storage *capacitor.*

An electrical capacitor behaves very much like a rechargeable battery. The storage capacitor charges up to the high voltage from the voltage converter, then suddenly dumps its charge into the flash tube to make the bright light.

A signal is required to tell the capacitor to dump its charge and cause the flash. This signal comes from the X-sync contacts in the camera. The signal wire in the drawing is shown connected to the flash tube itself, and you can think of it as turning on the flash. The flash turns itself off when the storage capacitor has discharged.

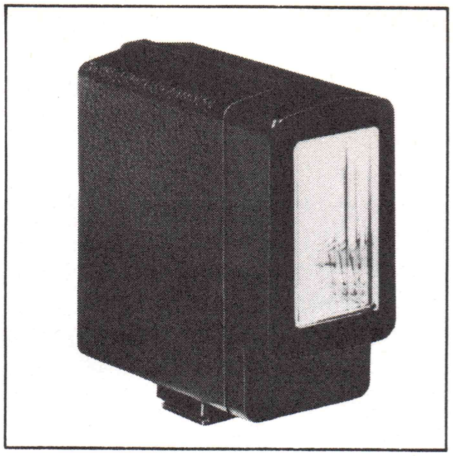
Once the flash has been fired, it cannot be operated again for a short period of time needed to charge up the capacitor again, called the *recycle* time.

With rechargeable batteries, longer recycle time tells you the batteries need charging. The flash may have an external charging adapter and an AC line cord for battery charging, or the adapter may be built into the unit. The specs on most accessory flash units give you an idea of the time needed to put enough charge back into the batteries to expose another roll of film. If your unit uses flashlight-type nonrechargeable batteries, use alkaline cells. They will give a lot more flashes than the common variety, before recycle time be-



NON-AUTOMATIC ELECTRONIC FLASH
Turn-on signal from camera X-contact
Power Source
Voltage Converter
Storage Capacitor
Flash Tube

Figure 16-1/When using a non-automatic electronic flash, camera-generated signal turns it on. Flash tube makes light until storage capacitor discharges to the point where flash tube extinguishes.



A wide variety of non-automatic flashes is available. The small shoe-mount types are convenient and relatively inexpensive.

comes excessively long or the unit won't recycle at all.

The type of capacitor used in electronic-flash units may deteriorate if left a long time without an electrical charge. Just before you put the flash away after shooting, it's a good idea to let it recycle so it is ready to shoot, but don't fire the flash. That allows you to store it in a charged condition. In long storage it is beneficial to turn on the flash unit and recharge the capacitor about once a month, returning it to storage in a charged condition.

Most electronic-flash units have a signal light, or ready light, which glows when the capacitor has enough charge to operate the flash.

GUIDE NUMBERS

Guide numbers are a guide to exposure using flash and apply both to flash bulbs and non-automatic electronic flash units. Higher guide numbers indicate more light from the flash.

Suppose a flash bulb or nonautomatic electronic-flash unit makes enough light to properly expose a subject at a certain distance from the camera. This implies a certain film speed, an aperture and shutter speed suitable for the film speed and the amount of light, and some distance between the light source and the subject.

Starting with that situation, the light source could be moved farther from the subject and proper exposure could still be made by opening the aperture to compensate for the reduced amount of light on the subject.

Variation of light on the subject due to a changed distance between flash and subject is assumed to follow the inverse-square law: Doubling the distance between light source and subject should reduce the amount of light by a factor of 4. There would be one-fourth the amount of light on the subject.

The aperture change to get the same exposure as before should be opening up two stops.

Now let's use some numbers to illustrate that. Suppose the light is 5 feet from the subject and a suitable aperture is *f*-16. Please notice that the distance in feet multiplied by the *f*-number is: 5 x 16 = 80.

Double the distance, to 10 feet, and open up the aperture two stops, to *f*-8. The product of distance times *f*-number is still 80.

All combinations of distance and *f*-number which produce the same exposure with that flash will have the same product—80 or whatever it turns out to be. That number is called a *guide number.*

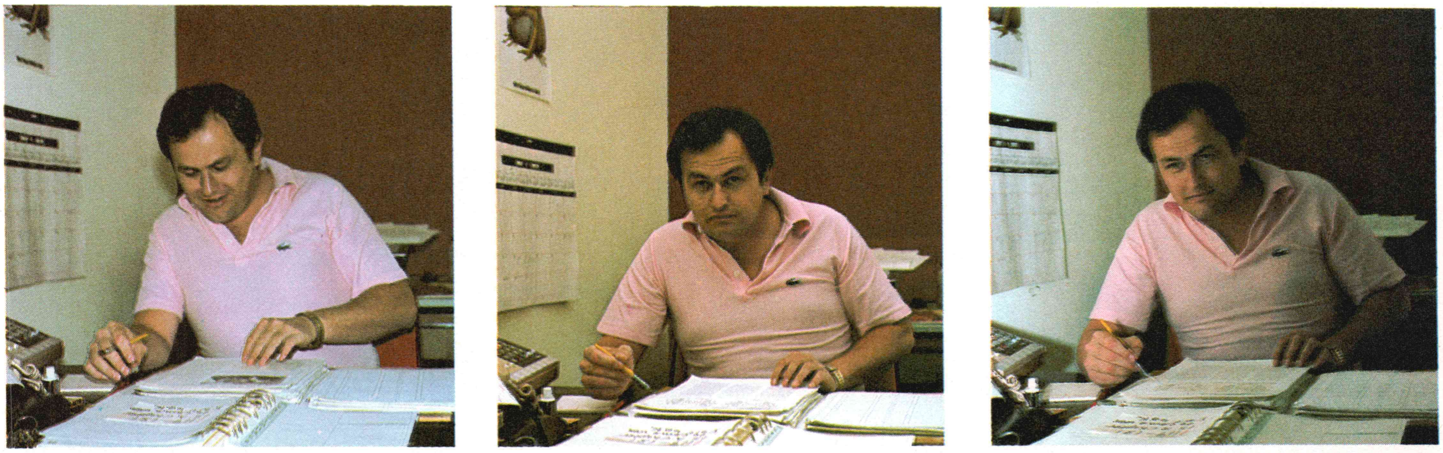
Obviously, guide numbers will be different for different film speeds because with faster film, you need less light on the subject. Shutter speed may be important. With bulb flash, which happens over a fairly long interval of time, shorter shutter speeds admit less of the total light produced by the flash bulb. Therefore guide numbers for flash bulbs are specified for a certain film speed *and* a certain shutter speed.

With electronic flash, film speed is important but shutter speed is not because the entire flash happens in a time interval much shorter than the shutter speed you are allowed to use with a focal-plane shutter. More on this point in a minute.

A non-automatic electronic flash may have a guide number of 60 feet for ASA 25. Here's how to use guide number (GN) to find the *f*-stop you should use:

f-number = GN/Distance

If the guide number is 60 feet, and you are shooting at a distance of 15 feet from the subject, the *f*-



Indoors you can use direct flash as at left, bounce it off the ceiling or a wall. Be wary of bouncing light off a colored surface because it colors the reflected light. Shot with a Canon 199A flash on an A-1 camera in the Electronic Flash AE mode.

number you should use is 60/15 = *f*-4.

If you move closer, say 7.5 feet to keep the arithmetic simple, the new aperture is 60/7.5 = *f*-8.

Notice that a guide number includes distance between light source and subject. If the distance is measured in feet, a certain guide number results. If measured in meters, a different guide number results. Unless you know if the number is based on feet or meters, you can miss exposure by working at the wrong *f*-stop.

Sometimes guide numbers are specified only for one film speed. If you decide to shoot with film of a different speed, you should know how to convert the guide number. Let's use the terms *New GN* and *New ASA* to mean the GN and film speed you intend to use. *Old GN* and *Old ASA* will mean the published guide number.

$$\text{New GN} = \text{Old GN} \times \sqrt{\frac{\text{New ASA}}{\text{Old ASA}}}$$

Sometimes the film speeds make the calculation easy. Suppose the guide number as stated in the specs is 60 feet with ASA 100 film. You intend to shoot with ASA 400 film.

$$\begin{aligned}\text{New GN} &= 60 \text{ feet} \times \sqrt{\frac{400}{100}}\\ &= 60 \text{ feet} \times \sqrt{4}\\ &= 60 \text{ feet} \times 2\\ &= 120 \text{ feet}\end{aligned}$$

If you switch to ASA 400 film instead of ASA 100 film, you can place the flash at double the distance *or* close down the aperture by two stops.

Guide numbers for electronic flash units are quoted at ASA 25 or ASA 100 or some other film speed. The flash unit "looks better" when a higher film speed is used as the base—because the guide number is higher. If you are shopping for an electronic flash, compare guide numbers based on the same film speed.

Guide numbers are just that—a guide. They are based on photographing people indoors because more flash is used for that purpose than any other. Some of the light from the flash bounces off ceiling and walls and then illuminates the subject while the shutter is still open. If you use flash outdoors, you will lose the light that would otherwise bounce off ceiling and walls and the picture may be underexposed. Try figuring *f*-stop with the guide number and then opening up one-half stop or more for outdoor locations.

ESTABLISHING YOUR OWN GUIDE NUMBERS

Because guide numbers are based on average conditions, the published guide number for your flash may not work well under your shooting conditions—such as a room with a high dark ceiling.

You can figure and assign your own guide number to your equipment and shooting environment by testing—remember that a guide number is just the product of distance and *f*-stop which gives a good exposure at a specified shutter speed.

A handy shooting distance for the test is ten feet from the subject. Use several different *f*-stops above and below the one suggested by the published guide number. Make notes or have the subject hold a card showing the *f*-stop for each exposure. After processing, pick the one you like best. The guide number for that situation is the *f*-stop used multiplied by the distance used. If you liked *f*-8 best, and you were testing at 10 feet, the guide number is 80 feet. Use color-slide film for the test.

FLASH WITH A FOCAL-PLANE SHUTTER

When shooting with flash, a focal-plane shutter is at a disadvantage.

The first curtain is released to make an exposure, and the second curtain follows behind at a time interval equal to the desired length of exposure. When the first curtain reaches the end of its travel, the film frame is uncovered *as far as the first curtain is concerned,* so it closes the electrical contacts for X sync and fires the flash.

If the second curtain is following closely behind the first, at 1/500 second for example, part of the frame will already have been covered up by the second curtain at the instant of the flash. The only part of the frame which could be exposed is the narrow slit between the two curtains.

To use electronic flash with a focal-plane shutter, a shutter speed must be selected so the first curtain reaches the end of its travel and then a brief instant passes before the second curtain *begins* its journey across the frame. During that brief instant, all of the frame is open to light and the flash occurs.

This means the exposure time on the shutter-speed dial must be slightly longer than the time required for the first curtain to travel across the frame. The time required for the first curtain to travel across the frame depends both on how fast it travels and how far it has to travel. Horizontally-moving shutters travel across the wide dimension of the frame—36mm. Vertical shutters travel across the narrow dimension of the frame—24mm.

Therefore vertically-moving focal-plane shutters synchronize with electronic flash at faster shutter speeds than horizontal shutters. Among the Canon SLR cameras, the EF uses a vertically-moving shutter and syncs with electronic flash at 1/125 second or slower. All other models use horizontal shutters and sync with flash at 1/60 second or slower.

At slower shutter speeds, the second curtain waits even longer before starting across the frame, so ordinary electronic flash works OK.

GHOST IMAGES

Electronic flash with a focal-plane shutter requires exposure of

1/125 or 1/60, minimum. But the actual time of exposure due to the bright light of the flash is very much shorter–1/500 second down to as little as 1/50,000 second or less in some cases. If there is enough illumination on the scene from sources other than the flash to cause some exposure during the full time the shutter is open, then there are *two* exposures. One short-time exposure due to the flash and another longer-time exposure due to the ambient light on the scene. If the subject moves during the time the shutter is open, or the camera moves, the image due to ambient light will not be in register with the image due to flash. This can cause a blur or a faint "echo" of the subject on the film.

With a motionless subject, the cure is to hold the camera still during the entire period of exposure. With a moving subject, there isn't much you can do about it except try to shoot so the flash is the dominant light and the other light on the subject is too dim to make a visible image on the print, or else pan with the subject.

LIGHTING RATIO

A thing to worry about with artificial lighting, and sometimes outdoors, is the difference in the amount of light on the best-lit areas of the subject and the amount in the worst-lit areas.

Direct sunlight from above or the side can spoil a portrait by casting deep and well-defined shadows of facial features. This can be helped by using reflectors to cast some light into the shadows, or using flash to *fill* some of the shadowed areas with more light–called *fill lighting.*

If you are using more than one source of light, you can usually control some or all of them to adjust both the amount of light and the directions of illumination on the subject. In portraiture and other kinds of photography, arrangement of lighting is important for artistic effect.

For a portrait, suppose there are two light sources such as flood lamps or flash. With the subject looking straight ahead, one light source is to the left at an angle of 45 degrees. Let's say this source puts 4 units of light on the subject.

Another source, at a 45 degree angle on the opposite side only puts one unit of light on the subject. This gives a *lighting ratio* of 4 to 1–which is simply the ratio of the two amounts of light.

On the subject, there are *three* values of light. Where illumination is only from the brighter source, the amount of light is 4 units. Where it is only from the less-bright source, which will be in the shadows cast by the brighter source, the illumination is one unit. Where both lights overlap and both illuminate the subject, the total light is 5 units. The *brightness ratio* is 5 to 1 because the brightest part is five times as bright as the darkest part.

In photographic exposure steps, a brightness ratio of 5 to 1 is only a fraction more than two steps, usually no problem for b&w film. It is often recommended as the upper limit for brightness variation in color photography because of the nature of color film.

Color film has two jobs to do. It must record differences in scene brightness, just as b&w film records the different brightnesses along the gray scale. In addition, it has to record color information.

A simple way to think about that is to remember that the brightness information gets on the film first. After that color is introduced by chemical processing. When there is conflict between brightness information and color, color loses.

By restricting the lighting ratio to about 4 to 1, giving a brightness ratio of 5 to 1 as measured by the exposure meter in your camera, you allow "room" on the film for both brightness and color variations. If the colors in the scene are very bold and vivid, you may need to hold the lighting ratio to 2:1.

With color, the colors themselves produce visual differences between objects in the scene, so we don't have to rely as much on brightness differences.

HOW TO CONTROL LIGHTING RATIO

If the lights are floods or flash, you can control the brightness of each source by selecting sources of different light output and you can control the amount of light from any source by adjusting the distance from source to scene. Sometimes this is more difficult in the real world than on paper.

A reasonable guide to incandescent-lamp light output is the wattage rating. You can confirm lighting ratio by measuring at the scene with a hand-held meter, or by moving your camera up close so it only "sees" parts of the scene. Measure the brightest part and the darkest part of interest.

With lights of the same intensity, control lighting ratio by moving one farther back. If they are located so they put the same amount of light on the scene, and then one is moved back to double the distance, the light from that one drops to one-fourth its former value due to the inverse-square law.

Using Flash for Fill Lighting–When using flash, you have to predict the amount of light on the scene when the flash happens. The simplest way is to use the guide number to figure *f*-stop and then consider the *f*-stop as an indicator of the amount of light. If you are using two flash units to make a portrait, one is located so it requires *f*-4 and the other requires *f*-8 to produce full exposure you will get a 4 to 1 lighting ratio by setting the camera at *f*-8.

Multiple flash units can be triggered by each other using connecting wires if the manufacturer designed them that way. They can also be triggered by light. One flash is operated by the camera. One or more additional flash units are equipped with an accessory light sensor which "sees" the light from

Outdoors, you can use flash to fill shadows caused by direct sunlight. Photos by Josh Young.

the main flash and triggers the other flash units. When so arranged, the additional flash units are called *slaves.*

If you have the lighting set for a 4 to 1 ratio, use the *f*-stop associated with the brighter light and ignore the other one. This is generally true of fill lighting whether by continuous light or flash.

USING FLASH IN SUNLIGHT

A special case of fill lighting with flash is when the main light is the sun.

With the shutter at the speed required for flash, and sunlight on the subject *at an angle which makes shadows,* the camera exposure setting should be for the main light source—the sun. Then locate the flash at the right distance from the subject so it gives the desired lighting ratio.

Here's a procedure for using flash fill lighting in sunlight.

1. Set the camera shutter speed as required for use with flash—1/60 or 1/125 depending on camera model.
2. Focus, meter the subject and set aperture for normal exposure using sunlight. Notice the distance from the camera location to the subject, either by reading the distance scale on the lens or actual measurement.
3. Using the guide number of the flash for the film speed you are using, calculate the flash *f*-stop for the distance between camera and subject. For a 4 to 1 lighting ratio, that *f*-stop as calculated should be two stops larger than the camera setting.
4. If it is not 2 stops larger, use the guide number to figure distance between flash and subject which will give the desired aperture.
5. Put the flash at that distance. Remember about flash outdoors being less effective than flash indoors where ceiling and wall reflections help. Fudge the flash forward a little ways to compensate. That's not scientific but it's practical.
6. Shoot at the camera setting you made for sunlight, *not* the larger aperture you calculated for normal exposure with the flash.

There is a handy mathematical coincidence that is useful when moving a flash or flood light to change the amount of light. Doubling distance reduces the amount of light on the subject by a factor of 4. Doubling the *f*-number at the camera also reduces the amount of exposure of the film by a factor of 4. The mathematical series used for *f*-numbers also applies to distances between light and subject.

LOCATING FLASH OR FLOOD LAMPS

To Decrease Illumination By:	Multiply Distance By:
Zero	1
1 stop	1.4
2 stops	2
3 stops	2.8
4 stops	4
5 stops	5.6
6 stops	8

If you have the type of flash which connects to the camera by a PC cord, you can locate the flash away from the camera by using PC cord extensions.

If you cannot remove the flash from the camera because it is a direct-connected hot-shoe type, then you can't use a different distance for flash and camera. It is always possible to find some distance that will give the lighting ratio you want, but that may not give good composition of the picture.

When your calculation indicates that the flash should be moved back to reduce its light, but you can't move it back independent of the camera, you can reduce the amount of light coming from the flash.

CAUTION: Flash *bulbs* get very hot. Don't touch one with your fingers.

With electronic flash which doesn't get hot, you can cover about half of the window that lets light out and about half of the light will come out—a reduction of one stop. Some photographers develop high skill at covering part or all of the electronic flash opening.

A practical rule is, one thickness of pocket handkerchief over an electronic flash cuts the light by one stop. Two thicknesses—two stops. Don't do this with flash bulbs.

Some electronic flash units come with neutral-density filters which fit over the window. 2X is one stop, 4X is 2 stops.

PROBLEMS WITH FLASH

Flash has several kinds of problems.

Flash on camera, very close to the axis of the lens can cause "red eye" when using color film. Light rays from the flash enter the subject's eyes and reflect back to the lens from the retina of the eye. The light will be colored red from the blood vessels in the eye. To avoid this, pocket cameras come with an extension which raises the flash bulb a few inches above the lens. Most SLR cameras mount a flash high enough to avoid this problem, but it is possible.

Flash on camera produces "flat" lighting because it is usually aimed straight at the face, eliminating all shadows. The exception of course is when the flash is used for fill lighting.

When people stand close to a wall while being photographed with flash on camera, there are often sharp shadows of the people visible on the wall behind them.

Mounting a flash on the camera is convenient because it is all one unit, but has those disadvantages. If the flash connects to the camera with a PC cord, and the cord is long enough, it is preferable to hold the flash high and to one side. This casts shadows similar to those caused by normal overhead lighting and the effect is more realistic. Also, a flash held high tends to move shadows on the wall downward and they may not be visible in close "head shots" of people.

The light from a single flash unit falls off drastically with increasing distance. If you photograph a group of people at different distances from the flash, and make a guide-number calculation for the middle of the group, people nearest the camera will be overexposed, those in the center will be OK and those in the background will be underexposed.

Using guide numbers to find *f*-stop is a bother, particularly when you are shooting in a hurry.

BOUNCE FLASH

A technique used to avoid flat lighting and harsh shadows from a single flash is to aim it at the ceiling. With a flash detached from the camera, just point it at an angle toward the ceiling so the bounced light will illuminate your subject. Some flash units intended for hot-shoe mounting have a swivel head so the light can be bounced.

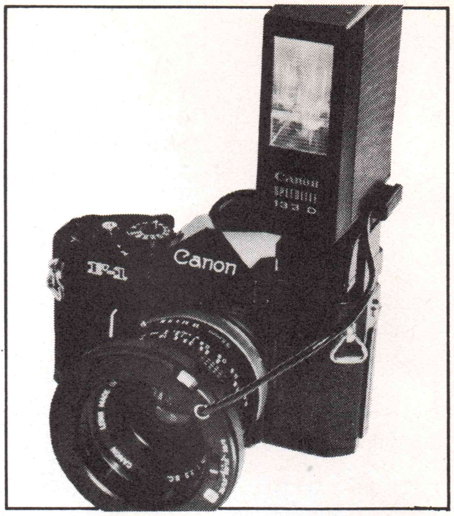
This has all the advantages of holding the flash unit high plus the added diffusion of the light from a broad area of the ceiling. If the ceiling is colored, it will also color the reflected light and change skintones in a color photograph.

To bounce with non-automatic flash, the distance to use in the guide-number calculation is the distance from flash to ceiling and then from ceiling to subject. With a little practice and a tape measure if necessary, you can learn to estimate this distance fairly well. You must also allow for light absorption by the ceiling which can require opening up one or two stops larger than the guide-number calculation suggests. A flash must be more powerful—meaning make more light—to be used this way but it is a much-improved method of taking flash pictures indoors.

THE CANON CAT SYSTEM

CAT means Canon Auto-Tune. It is a shoe-mounted electronic flash and a signaling ring which fits over the front of the lens.

Only the F-1, EF and FTb cameras can use the CAT system, and these only with certain 35mm and 50mm lenses. It completely eliminates guide-number calculations and makes use of flash simple. You operate the camera just as you would without the flash unit attached: Focus, adjust the exposure controls and shoot. The CAT flash system controls the display in the camera so you automatically get the correct amount of flash just by matching needles in the display. With the EF camera, you don't have to match needles—the camera does it all. Just focus and shoot.



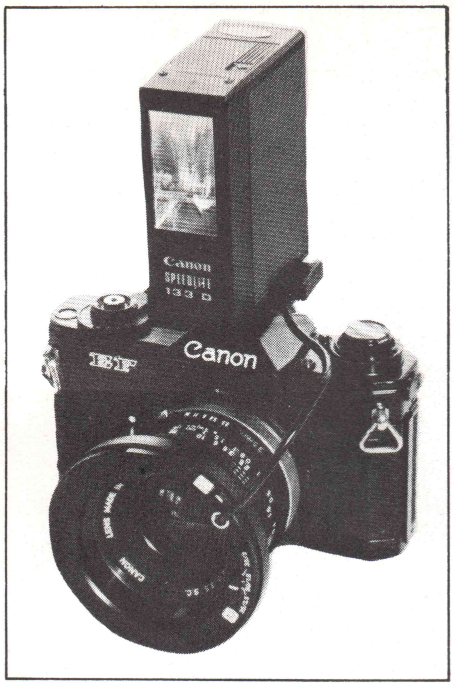
The Canon CAT flash system uses an electronic flash unit on the camera hot shoe, connected by an electrical cord to a distance-sensing Flash-Auto Ring mounted on the lens. Only certain Canon lenses can be used with the complete system as shown. The flash unit—Speedlite 133D—can be used alone as a non-automatic flash with any hot-shoe-equipped camera and any lens.

Basically, the CAT system does the guide-number calculation for you. Thus it must know distance to the subject you have in focus. It receives focused-distance information from a signaling ring you attach to the front of the lens.

The signaling ring, called a Flash-Auto Ring, has an outer case which is solidly mounted to the bayonet fitting on the end of the lens. Inside the case is a movable element which is driven by a pin on the focusing ring of any Canon lens intended for use with this system.

The exposure calculator in the camera will figure and display the *f*-stop to use. It does that and one more important thing—it checks battery voltage in the flash unit and adjusts the display accordingly.

Users of Canon equipment are already accustomed to the match-needle display, so it is used in



The CAT flash system on the EF camera makes flash photography totally automatic. Set shutter speed to 1/125, focus and shoot. The camera sets aperture for you. If the meter needle indicates any *f*-number in the display, camera will use that *f*-stop and exposure will normally be satisfactory.

exactly the same way for automatic flash with the CAT system. The Meter Needle moves in the viewfinder display according to both focused distance and battery voltage of the electronic flash. When the flash is ready to fire, the Meter Needle moves up quickly from the underexposure band at the bottom of the display.

Be sure you have shutter speed set correctly for flash, match the needles in the display and take the picture. An EF camera on automatic even sets aperture for you. When the ready light of the flash unit comes on, focus and shoot.

The F-1 camera has a removable pentaprism, so there is no hot shoe located on top. The hot shoe, called Flash Coupler L, clips over the rewind knob on the camera and makes contact with electrical terminals at the base of the knob. Except for this mechanical difference, operation is the same as described above.

Hardware for the CAT System—Speedlite 133D can be used with the FTb, F-1 and EF cameras.

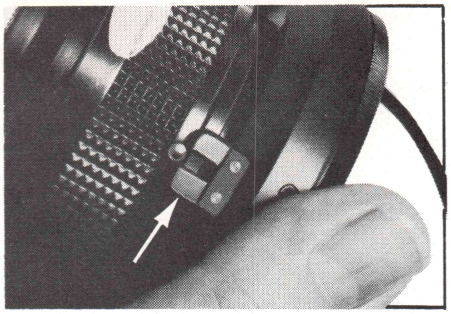
For cameras using the CAT system, some lenses have a projecting pin to mate with the Flash-Auto Ring. There are two Flash-Auto Rings, A2 and B2. The A2 ring is used with Canon lens FD 50mm *f*-1.8 S.C., FD 35mm *f*-2 S.S.C., and FD 35mm *f*-3.5 S.C. The B2 ring is used with FD 50mm *f*-1.4 S.S.C., FD 35mm *f*-2 S.S.C., and FD 35mm *f*-3.5 S.C.

Because the CAT Speedlite makes a fixed amount of light each time it flashes, there is a limit to how close you can get to your subject, even with the lens aperture set as small as possible. The Flash-Auto Ring attachments limit movement of the focusing control on the lens so you can't focus closer than this minimum distance.

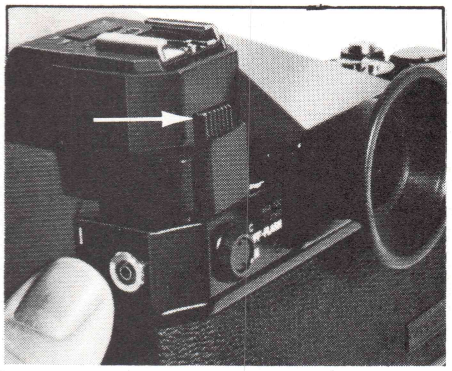
To mount the Speedlite on the F-1, Flash Coupler L has the necessary contacts. To mount other flash units on the F-1, which do not have the CAT capability and need only a single contact to fire the flash, use Flash Coupler D.

In late 1976, Canon changed the 50mm *f*-1.8 lens to make it physically smaller and changed the Flash-Auto Ring A2 so it will fit the redesigned lens. Purchasers of this lens and a CAT flash system in 1977 or later should receive parts that fit. It is possible, of course, to end up with a combination that won't fit if you have an early lens and a late Flash-Auto Ring, or the reverse. If so, contact your nearest Canon Factory Service Center through your local dealer. They will replace or modify the Flash-Auto Ring as needed.

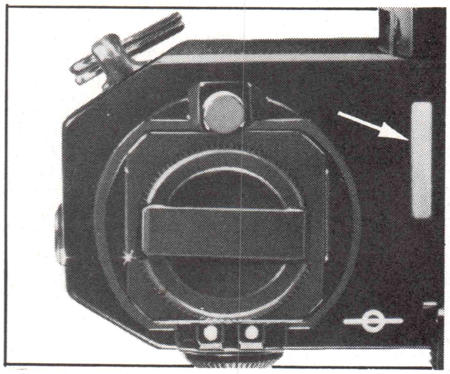
For its intended purpose, the CAT system does a good job. It can be used as a shoe-mounted flash, either on automatic or non-automatic. In the automatic mode it works with Canon 50mm and 35mm lenses. In non-automatic, it works with any lens, using guide-number calculations. The guide



Flash-Auto Ring mounts same as lens hood, except pin on lens focusing ring must be caught in yoke on Flash-Auto Ring (arrow). Accessory screw-in lens hoods can be screwed into Flash-Auto Ring.



The F-1 camera uses Flash Coupler L to mount the CAT flash. Cord-connected flash units can mount in the shoe and use flash socket on camera body. Slide-button on back of Flash-Coupler L (arrow) turns on built-in lamp to illuminate viewfinder display in F-1. This is handy in dim light whether using flash or not.



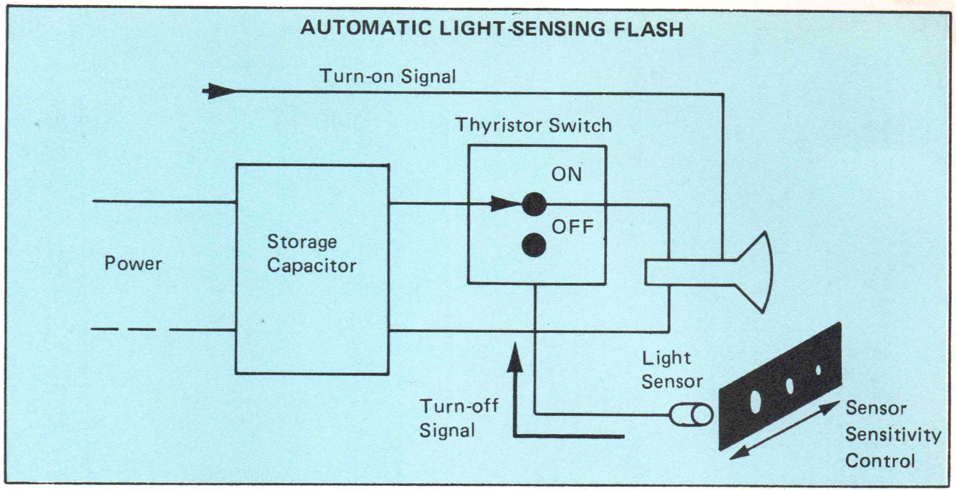
Most Canon cameras use light coming through the lens to illuminate the viewfinder display. The F-1 uses overhead illumination and has a special rectangular window just left of the pentaprism to admit light. When the lamp in Flash Coupler L is switched on for a brighter display of the match-needles, it casts light through this window.

number of 66 feet at ASA 100 converts to 33 feet at ASA 25, which compares with similar shoe-mount units of other brands.

AUTOMATIC ELECTRONIC FLASH

The CAT system is automatic in the sense that you don't have to use guide numbers or do any calculating. However, popular use of the word *automatic,* with respect to electronic flash, means something different.

Automatic electronic-flash units measure the amount of light reflected from the subject and automatically turn off the flash when the desired amount of light has been measured. No guide-number calculation is necessary.



Light-sensing auto-flash units are turned on by X contact in the camera. Light sensor controls *time duration* of flash, turns off flash unit at standard amount of exposure. Sensitivity control determines the *f*-stop that should be set at the camera.

How Light-Sensing Automatic Flash Works—The light-measuring sensor of most automatic flash units is mounted in the housing, so it is pointed toward the subject.

A turn-on signal comes to the flash tube from the camera. The light sensor measures exposure and at a *standard amount of exposure* it generates a turn-off signal.

It is possible to work at a shorter distance by closing down aperture so the camera accepts less light, and it is also possible to work at different film speeds by changing aperture on the camera. Shutter speed cannot be changed because it must be at the flash setting.

You set film speed into your camera and also into the calculator on the automatic flash. Then the calculator on the flash unit displays an *f*-stop for the camera along with a maximum shooting distance and sometimes a minimum distance. If you set the lens for that *f*-stop, you can shoot automatically anywhere within the specified distance range without changing *f*-stop of the lens.

Suppose the distance range shown by the calculator is from 2 to 18 feet, and the *f*-stop is *f*-4. If the subject is at the maximum distance in that range, the automatic flash will operate as long as it can. If you shoot at a shorter distance, the sensor on the flash receives more light from the nearer subject and decides that exposure is correct with a shorter time duration of the flash. It turns off sooner. At the shortest range—2 feet—the unit turns on and then turns back off again as fast as possible.

The sensor in the flash unit is really measuring exposure *on behalf* of the camera. When the sensor on the flash receives what it "thinks" is correct exposure, the actual exposure on the film in the camera should be correct.

Some automatic flash units allow you to choose from 2 or more *f*-stops at the camera and make a sensitivity adjustment to the sensor of the flash so it will still give correct exposure. Choice of *f*-stop gives you some control over depth of field.

Some automatic flash units are built with swivel heads to allow bouncing the light off the ceiling. The sensor does not swivel but continues to look where the camera does—assuming the flash is mounted on the camera. Thus the flash also compensates automatically for light loss due to bouncing and will not shut off until the proper amount of exposure is received. Naturally the flash must have enough power to bounce light off the ceiling.

Some automatic flashes are detachable from the camera but have a small light sensor which mounts on the camera. This allows you to point the light in any direction and hold it anywhere. Meanwhile the sensor mounted on the camera still does its job of keeping the light on until it thinks the film got enough exposure.

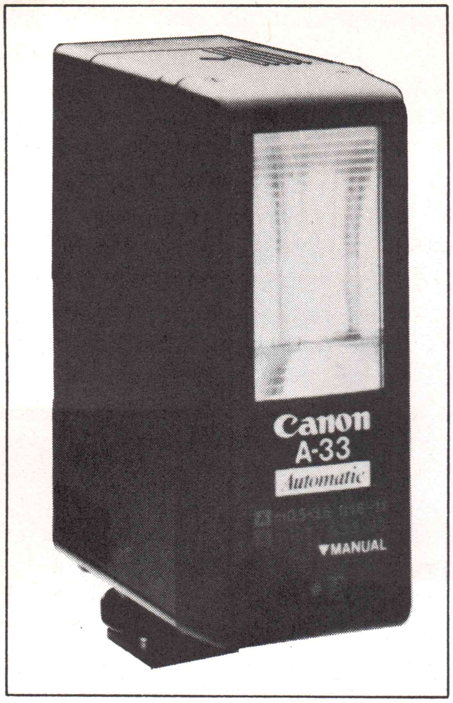
Automatic flash units with a sensor-sensitivity control normally have one position of the control which allows the flash to run for maximum time duration at every firing. It puts the automatic flash on non-automatic or manual operation. Then you use it with its guide number just like any other non-auto flash.

CANON AUTOMATIC LIGHT-SENSING FLASH UNITS

Canon offers a series of general-purpose light-sensing auto flash units to work with any camera that has X-sync. These are described here with a summary table of specifications at the end of this chapter.

A-33—A simple, compact and economical flash unit that mounts in a hot shoe or can be cord-connected to a camera-body flash terminal using any standard PC cord. A PC cord, called Synchro Cord D, is furnished with the flash.

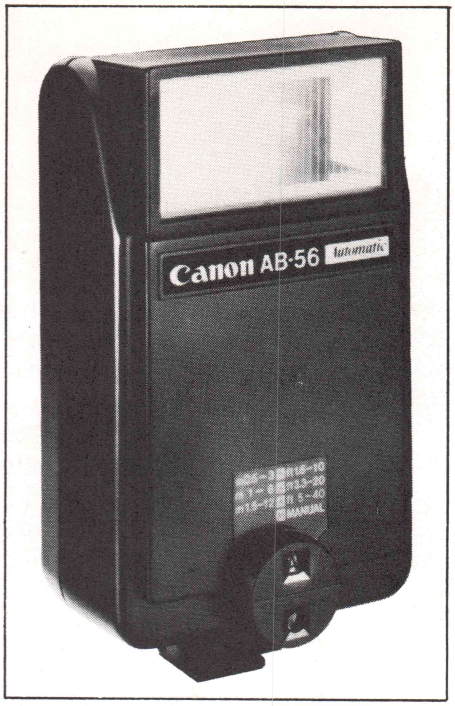
With an ASA-25 guide number of 33 feet, this unit doesn't have



Canon A-33 Automatic Flash unit offers two distance ranges and two *f*-stops for automatic operation. Can be set to manual and used as non-automatic flash with guide number of 33 feet with ASA 25 film. This flash can be used in a hot shoe or cord-connected to any camera with X sync.

Canon AB-46 Automatic
▼MANUAL

Canon AB-46 Automatic Flash can be used in a hot shoe or cord-connected to any camera with X-sync. Flash head swivels upward for bounce flash with detents at 60° and 75°. Offers two distance ranges and two *f*-stops for automatic operation. Can be set to manual operation with guide number of 46 feet with ASA 25 film.



AB-56 has a removable light sensor which can be attached to a hot shoe using Sensor Adapter AB-56. This allows cord-connecting flash so you can point it in any direction while sensor measures light actually reaching subject. Unit also provides bounce flash when mounted in a hot shoe. Has 3 distance ranges and choice of 3 *f*-stops. Manual guide number is 56 feet with ASA 25 film.

enough light output for most bounce-flash situations, so the flash head does not swivel upward to allow shoe-mounted bounce.

The A-33 uses 4 size AA batteries; either Alkaline or NiCad. For battery replacement you can use a set of 4 G.E. NiCad batteries and a G.E. battery charger to restore the charge in the NiCads.

The three-position slide on the front of the flash selects two distance ranges for automatic operation and has a position for manual guide-number operation. The distance ranges are color-coded.

Higher ASA film speeds allow use of smaller lens apertures as shown on the calculator dial mounted on the back of the flash. The calculator dial lights up when you touch it.

You always have a choice of two aperture settings for each film speed. The distance ranges for automatic operation do not change with film speed—the longer distance always goes with the larger of the two usable apertures.

Switching the flash unit to M, for manual, disables the light sensor and causes the flash to operate like any other non-auto flash with a guide number.

The A-33 does not use *energy-saving* circuitry, sometimes called *series* circuitry. This means the flash uses the same amount of battery power every time it fires—and it always uses the amount of power needed for the longest possible flash even though the actual flash duration is short due to automatic operation of the flash.

If you use flash a lot and intend to use it mainly on automatic, one of the energy-saving Canon flashes listed in the table on page 136, may be better for you. For example, with alkaline batteries, the A-33 gets 250 flashes on either manual or automatic. The AB-46 has energy-saving circuitry which is effective on automatic. With alkaline batteries, it gets from 120 to 1200 flashes, depending on reflectance of the subject and distance to the subject.

With a subject that requires the flash to run as long as it can, energy-saving circuitry has no advantage—the power drain is the same as if the flash were on manual operation.

AB-46—With an ASA-25 guide number of 46 feet, this flash has enough light output to bounce off ceilings, so the flash head swivels upward.

Because the flash sensor measures light returning from the subject, no calculations are required for bounce flash, provided the subject is within the maximum operating range of the flash unit. When used for bounce, the travel path of the bounced light must be less than the maximum operating range of the flash. Because of light absorption at the bounce surface. Maximum operating range may be only about half of the specified range for non-bounce applications.

The flash can be cord-connected to an X-sync flash terminal using any standard PC cord or Canon Synchro Cord D, which is included with the flash.

Beam angles are wide enough to cover the field of view of a 35mm lens. Wide Adapter AB-46 comes with the flash unit. It clips over the flash window and widens beam angles so as to cover the field of view of a 28mm lens. The Wide Adapter reduces the ASA-25 guide number to 33 feet.

The AB-46 uses 4 size AA batteries, either Alkaline or NiCad. For battery replacement you can use a set of 4 G.E. NiCad batteries and a G.E. battery charger to restore the charge in the NiCads.

A three-position slide-switch on the front selects manual or two auto modes identified by red and green colors.

Using faster film allows use of smaller aperture as shown by the calculator dial on the back of the flash. The dial lights up when you touch it. The two distance ranges for automatic operation remain the same with all film speeds. The longer distance always goes with the larger of the two usable aperture settings.

Switching the flash unit to M for manual, disables the light sensor and causes the flash to operate like any other non-auto flash with a guide number.

The AB-46 uses energy-saving circuitry when operated as an automatic flash.

AB-56—More light output and versatility of use are features of the AB-56. It gives you the choice of three automatic distance ranges and three associated *f*-stops for each film speed. These are selected by a rotating control on the front of the flash. The automatic positions are color-coded with the letter A shown in red, green and blue. There is also a manual switch position, marked M.

Available *f*-stops are shown in the flash-comparison table on page 136 and on the calculator dial on the back of the flash. The dial lights up when you touch it.

The AB-56 has an ASA-25 guide number of 56 feet, as the nomenclature indicates, and covers the field of view of a 35mm lens. Wide Adapter AB-56 is included with the flash unit. When clipped over the flash window, the adapter widens the beam to cover the angle of view of a 28mm lens and reduces the ASA-25 guide number to 40 feet.

The unit can be shoe mounted or cord-connected to a camera-body sync terminal with any standard PC cord or Canon Synchro Cord D which is included with the flash.

When shoe-mounted, the flash can be bounced off the ceiling by tipping the flash head up.

When cord-connected, the flash can be bounced in any direction under automatic control of the sensor. This is done by removing the light sensor from the flash and installing it in the camera hot shoe, using the optional Sensor Adapter AB-56 which includes the necessary connecting cord. Because the sensor is mounted on the camera, it always views the subject being photographed, no matter what direction the flash is pointed.

The AB-56 uses 4 size AA batteries, either Alkaline or NiCad.

For battery replacement you can use a set of 4 G.E. NiCad batteries and a G.E. battery charger to restore the charge in the NiCads.

To save the batteries when AC power is available, the AB-56 can be plugged into a wall receptacle using an optional power cord accessory.

This is also an energy-saving flash when operated on automatic.

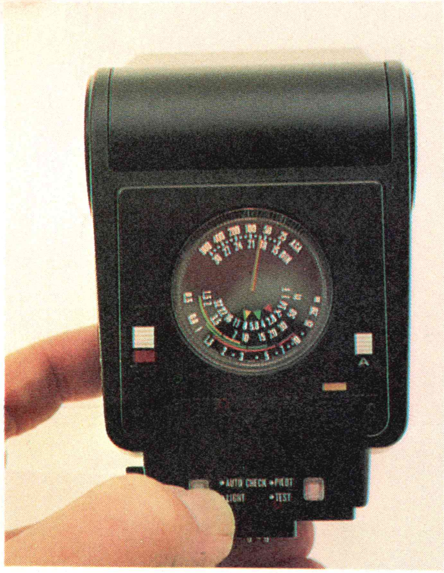
SPECIAL FLASH UNITS FOR A-SERIES CAMERAS

Canon has developed two special electronic flash units, 199A and 155A, for use with A-series cameras. They can also be used as light-sensing automatics with any other camera having X sync, but without special features. Because A-series cameras (A-1, AE-1, AT-1) all have some functions controlled electronically, these special flash units can make some camera control settings automatically as shown in the table on page 134. This happens when the flash is installed in the hot shoe of an A-series camera—making use of one or two additional electrical contacts which are in the hot shoe for this purpose.

Canon Speedlite 199A—Introduced simultaneously with the A-1 camera, this flash can do more "tricks" with the A-1 than with other models, however it can be used with any A-series camera with some automatic interaction between flash and camera. See photo on page 123.

The 199A is energy-saving on automatic with an ASA-25 guide number of 50 feet and a movable flash head that can be rotated upward for bounce flash. The light sensor is in the body of the flash and remains pointed straight ahead.

When the 199A is installed, turned on and ready to fire, the flash Pilot Lamp lights up. The instant this lamp glows, the flash takes control of the camera. It *can* set *both* shutter speed and aperture, depending on which camera is being used and how the camera controls are set. The Pilot Lamp is off during initial charge and recharge. While the Pilot Lamp is off, the camera operates as though the flash were not installed. Also, if you leave the flash on the camera, but turn the Main Switch off, the camera operates as though the flash were not installed.



ON-OFF switch of 199A flash unit is at left, by my index finger. Opposite is the Aperture Selector control which has three automatic settings indicated by letter A and appropriate color in adjacent window, and one manual setting indicated by M. Here set to yellow automatic operating range. PILOT lamp at lower right glows when flash is ready to fire. Depress PILOT Lamp and it serves as TEST button, firing the flash. If flash sensor measures enough reflected light from subject, AUTO CHECK lamp at lower left glows green. Depress AUTO CHECK lamp and it serves as Light button to illuminate calculator dial so you can see it in dim light.

When the flash sets shutter speed automatically, it selects X sync for A-series cameras, which is 1/60 second. There is an exception: When installed on an A-1, a special procedure lets you use shutter speeds of 1/30 to 30 seconds while retaining all automatic features of the flash. This procedure is described in the A-1 discussion in Chapter 18.

The Pilot Lamp is a two-stage indicator. When the flash unit has recharged enough to flash, the light turns on. After that, recharge continues at a slower rate. When the flash is fully recharged, the Pilot Lamp blinks on and off. It will make about 1/2 step more light when fully recharged, however this is significant only when the flash is switched to non-automatic operation. When used on automatic, the light sensor controls exposure no matter how bright the flash is. If you are using the flash as a non-auto unit, you will get more uniform lighting if you always trigger the flash when the lamp first turns on, or else always wait for the lamp to blink.

The Aperture Selector has one setting for non-automatic guide-number operation, labeled M, and three settings for light-sensing automatic operation, labeled A. Each of the three automatic settings is identified by a color visible through an adjacent window: red, green or yellow.

To operate, turn the Main Switch ON. Turn the calculator dial so the red index mark aligns with the film speed you are using. Choose one of the three operating ranges from a distance scale on the calculator dial—one is in feet, the other in meters. Each of the ranges is identified by a band of color which extends from a maximum to a minimum operating distance. The three colors are red, green and yellow. Three triangular color-coded pointers on the calculator dial indicate three apertures for automatic control—one for each distance range. Set the Aperture Selector to the color corresponding to the distance range you want to use. Example: at ASA 100, the red band extends from about 32 feet to 4 feet at *f*-2.8. The main subject should be kept within the selected operating range when shooting.

If you are setting lens aperture manually, the viewfinder readout will show a red letter M. You must set the lens to the aperture indicated for the range you have chosen. If the 199A is setting aperture for you automatically, it will make that setting. Specific control settings for these methods of operation are in the table on page 161.

The three usable *f*-stops change when you change the film-speed setting of the calculator dial.

The beam angles cover the field of a 35mm lens. A Wide Adapter included with the flash can be used to increase beam angles to cover the field of a 24mm lens if desired, with a reduced ASA 25 guide number of 30 feet. The flash can still be used on automatic operation with the Wide Adapter. You can also use the calculator dial to read maximum range with the adapter by observing the small gap in each color band. The gap indicates maximum operating range when the wide adapter is installed.

The 199A can be shoe-mounted or cord-connected to a camera-body sync terminal using optional Synchro Cord A. It uses 4 AA batteries, either alkaline or NiCad. For battery replacement, you can use a set of 4 G.E. NiCad batteries

A-SERIES CAMERAS AND SPECIAL FLASH UNITS			
FLASH	CAMERA		
	A-1	AE-1	AT-1
199A	Shutter speed and aperture set automatically. Special procedure allows use of 1/30 to 30 second exposures with automatic features.	Shutter speed and aperture set automatically.	Shutter speed set automatically. You set aperture.
155A	Shutter speed and aperture set automatically.	Shutter speed and aperture set automatically.	Shutter speed set automatically. You set aperture.

Automatic settings by special Canon flash units with A-series cameras are shown, assuming that camera and flash are both set for maximum use of automatic features. The 199A and A-1 have several other modes of operation, described in Chapter 18.

and a G.E. NiCad battery charger.

When using a light-sensing automatic flash on a camera with Power Winder A or Motor Drive MA, the flash can make a number of flashes in sequence in synchronism with the winder or motor drive. The number of flashes is determined by the distance to the subject and its reflectance. Highly reflective or nearby subjects give more flashes because less energy is used for each flash. If you make sequence photos, allow time for the flash unit to cool between flash sequences.

Canon Speedlite 155A—This is a simpler, lower-powered version of the 199A without bounce-flash capability. It has two *f*-stops instead of three. The 155A is an energy-saving automatic with an ASA-25 guide number of 28 feet.

Operation is generally similar. When installed and turned on, the 155A takes control of an A-series camera the instant the Pilot Lamp turns on. It sets shutter speed, or both shutter and aperture, depending on which camera model is being used and the camera control settings. See the accompanying table.

When the Pilot Lamp is off during recharge, or when the flash unit Main Switch is off, the camera operates as though the flash were not installed. The Pilot Lamp is not a two-stage indicator as in the 199A.

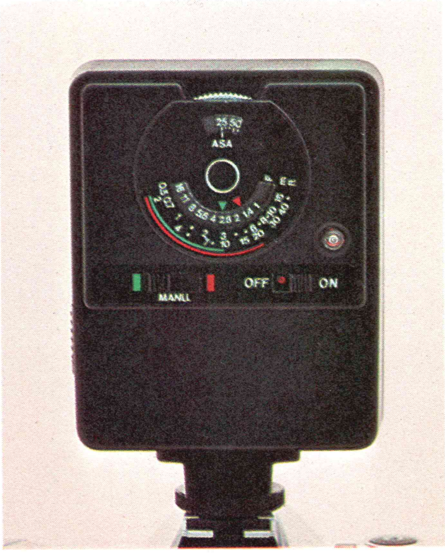
When the flash sets shutter speed automatically, it selects 1/60 second, the X-sync speed for A-series cameras. It does not have the capability to work at slower shutter speeds with the A-1 camera.

The Aperture Selector has one setting for non-automatic guide-number operation, labeled MANU, and two settings for light-sensing automatic operation, color-coded red and green.

To operate, turn the Main Switch ON and set ASA film speed into the calculator dial on the back of the flash housing. Choose one of the two operating ranges. The red setting is always from 2 to 20 feet; green is always from 2 to 10 feet. These two operating ranges use two different *f*-stops, indicated by red and green triangles on the calculator dial. The *f*-stops change when you change film speed. For example, at ASA 25, red is *f*-1.4 and green is *f*-2.8. At ASA 100, red is *f*-2.8 and green is *f*-5.6 which gives more depth of field.

Speedlite 155A is an automatic light-sensing flash designed to work with A-series cameras. It can be used with any camera with an X contact for electronic flash.

If the 155A is setting aperture automatically, it will set the camera to the aperture indicated on the calculator dial. If you are setting aperture manually, you must set it yourself.



Calculator dial shows choice of two *f*-stops for each ASA film speed so you have some control over depth of field.

The beam angles cover the field of a 35mm lens. No wide adapter is available to alter beam angle for use with shorter-focal-length lenses. The flash unit can be shoe-mounted or cord-connected to a camera-body sync terminal using optional Synchro Cord A. It uses 4 AA batteries, either alkaline or NiCad. For battery replacement, you can use a set of 4 G.E. NiCad batteries and a G.E. NiCad battery charger.

When using a light-sensing automatic flash on a camera with Power Winder A or Motor Drive MA, the 155A can make a number of flashes in sequence, in synchronism with the winder or motor drive. The number of flashes is determined by the distance to the subject and reflectance. Highly reflective or nearby subjects give more flashes because less energy is used for each flash. If you make sequence photos, allow time for the flash unit to cool between flash sequences.

IF RECYCLE TIME IS IMPORTANT

As you can see in the table on the following page, recycle time for the Canon automatic flash units may be considerably longer with alkaline batteries than with fully charged NiCad batteries.

In the manual mode, recycle time with alkaline batteries is nearly twice as long in come cases. When switched to automatic, recycle time depends on how much energy was used to make the preceding flash. With a subject that is both dark and distant, the flash runs longer before shutting off and uses more electrical energy from the storage capacitor.

In the extreme case for automatic operation, the flash runs as long as it can — which uses the same amount of electrical energy as manual operation. Therefore the *longest* recycle time on automatic is the same as on manual, and also nearly twice as long with alkaline cells as with fully charged NiCads.

CANON AUTOMATIC FLASH COMPARISON TABLE

	A-33	AB-46	AB-56	Speedlite 155A	Speedlite 199A
Guide Number					
ASA 25	33 ft., 10m	46 ft., 14m	56 ft., 17m	28 ft., 8.5m	50 ft., 15m
ASA 100	66 ft., 20m	92 ft., 28m	112 ft., 34m	56 ft., 17m	100ft., 30m
Guide Number with Wide Adapter					
ASA 25		33 ft., 10m	40 ft., 12m		30ft., 9m
ASA 100		66 ft., 20m	79 ft., 24m		60 ft., 18m
Sync Connection	Hot shoe or PC cord or Synchro Cord D	Hot shoe or PC cord or Synchro Cord D	Hot shoe or PC cord or Synchro Cord D	Hot shoe or Synchro Cord A	Hot shoe or Synchro Cord A
Typical Aperture Choices*					
ASA 25	*f*-1.4, *f*-2.8	*f*-1.4, *f*-2.8	*f*-1.8, *f*-2.8, *f*-5.6	*f*-1.4, *f*-2.8	*f*-1.4, *f*-2.8, *f*-5.6
ASA 100	*f*-2.8, *f*-5.6	*f*-2.8, *f*-5.6	*f*-2.8, *f*-5.6, *f*-11	*f*-2.8, *f*-5.6	*f*-2.8, *f*-5.6, *f*-11
Distance Ranges for Automatic Operation					
Red	3.3 to 23 ft. 1 to 7m	3.3 to 33 ft. 1 to 10m	5 to 40 ft. 1.5 to 12m	1.6 to 20 ft. 0.5 to 6m	5 to 35 feet 1.5 to 10.6 m
Green	1.6 to 11 ft. 0.5 to 3.5m	1.6 to 16 ft. 0.5 to 5m	3.3 to 20 ft. 1 to 6m	1.6 to 10 ft. 0.5 to 3m	3 to 17 ft. 1.0 to 5.3m
Blue or Yellow			1.6 to 16 ft. 0.5 to 3m		1.6 to 8.5 ft. 0.5 to 2.6m
Switchable to Manual	Yes	Yes	Yes	Yes	Yes
Typical Flash Recycle Time (Seconds)					
Alkaline Batteries					
Automatic	6	0.35 to 9	0.5 to 11	0.5 to 7	0.2 to 10
Manual	6	9	11	7	10
NiCad Batteries					
Automatic	2	0.35 to 5	0.5 to 6	0.5 to 5	0.2 to 6
Manual	2	5	6	5	6
Bounce Capability in Hot Shoe	No	Yes	Yes	No	Yes
Number of Flashes to Discharge Batteries					
Alkaline Batteries					
Automatic	250	120 to 1200	100 to 1000	300+	100 to 1000
Manual	250	120	100	300+	100+
NiCad Batteries					
Automatic	80	60 to 600	50 to 500	90+	50 to 500
Manual	80	60	50	90+	50+

CANON AUTOMATIC FLASH COMPARISON TABLE
(Continued)

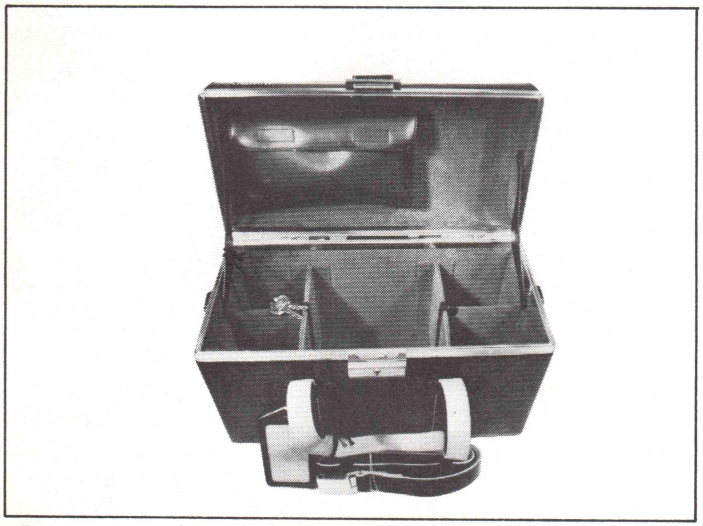
	A-33	AB-46	AB-56	Speedlite 155A	Speedlite 199A
Beam Angles **Horizontal** **Vertical**	60° 45°	60° 45°	60° 45°	60° 45°	60° 45°
Beam Angles with Wide Adapter **Horizontal** **Vertical**		70° 53°	70° 53°		75° 57°
Batteries	4 AA size Alkaline or NiCad	4 AA size Alkaline or NiCad	4 AA size Alkaline or NiCad	4 AA size Alkaline or NiCad	4AA size Alkaline or NiCad
ASA Film Speed Range of Calculator	25 to 800	25 to 800	25 to 800	25 to 800	25 to 800
Aperture Range of Calculator	*f*-1 to *f*-32	*f*-1 to *f*-32	*f*-1 to *f*-32	*f*-1 to *f*-32	*f*-1 to *f*-32
Dimensions (W x D x H)	1-5/8″ x 3-3/16″ x 4-1/4″ 36mm x 79mm x 107mm	3″ x 1-1/2″ x 5-5/8″ 75mm x 40mm x 141mm	3-1/4″ x 2″ x 5-7/8″ 80mm x 52mm x 146mm	2-7/8″ x 2-1/8″ x 2-1/4″ 70mm x 51mm x 105mm	3-1/8″ x 3-1/4″ x 4-9/16″ 79mm x 83mm x 116mm
Weight with 4 AA Alkaline Batteries	10 oz. 285g	13 oz. 380g	15 oz. 425g	10.5 oz. 300g	17.2 oz. 490g
Accessories Included	Case Synchro Cord D Battery Magazine D	Case Synchro Cord D Battery Magazine D Wide Adapter AB-46	Case Synchro Cord D Battery Magazine D Wide Adapter AB-56	Case Synchro Cord A	Case Battery Magazine D Wide Adapter
Optional Accessories			Sensor Adapter AB-56 AC Power Cord		Synchro Cord A
Special Features		Energy-Saving Circuitry	Energy-Saving Circuitry Removable Sensor	Energy-Saving Circuitry Sets A-1 and AE-1 shutter speed and aperture automatically. Sets AT-1 shutter speed automatically.	Energy-Saving Circuitry Sets A-1 and AE-1 shutter speed and aperture automatically. Sets AT-1 shutter speed automatically.

* Calculator on back of flash unit gives additional aperture choices, depending on film-speed setting.

17

HOW TO CARE FOR YOUR CAMERA

by John Wall, Canon Technical Representative



Protect your camera system by using a suitable case for storage and transit. Gadget Bag G-1 (left) holds two or three camera bodies, a good assortment of lenses and other accessories. Gadget Bag 4 is a medium-size case.

The best care you can give your camera is to use it regularly; keep it clean and protected from dirt, mechanical damage or abuse; inspect it and test it occasionally to be sure it is functioning properly.

With a new camera, the first thing you should do is study the operating instructions and then shoot a test roll of film. Color-slide film is the best choice for most people when making camera tests because the film-processing laboratory makes no corrections for bad exposure. What you see on the slide is what happened in your camera.

In making a test roll, don't try to make the world's best artistic shots. Shoot a variety of scenes in direct sunlight, in the shade, indoors, indoors with flash, long exposures, short exposures and so forth. What you are trying to do is use the camera in a variety of shooting situations. When you examine the slides, you will see if the camera or operator malfunctioned.

It's very unlikely that a Canon camera will not perform satisfactorily if it is operated properly. But if you think there may be something wrong, take the camera and the slides you shot to your dealer and discuss the apparent problem. If it needs a repair or adjustment under the warranty, your dealer can handle it for you.

It's also very unlikely that you will make any mistakes as the camera operator if you have read this book. Shoot the test roll anyway, so you will *know* that the camera and you are both doing it right.

Before leaving on that once-in-a-lifetime trip, have your camera checked by a Canon Factory Service Center or an independent Canon Authorized Service Facility. Then shoot a test roll to be sure you are going to get good pictures on your trip.

We have all heard sad stories about people taking a long trip and coming back with 50 rolls of nothing. A traveler bought a new camera and thought he only had to drop in the film cartridge to load it. He never once threaded the film into the take-up spool so he never got any pictures. Shooting a test roll

The camera doesn't have to be removed from this type of case to take a picture. The top and front part of the case swings forward and down out of the way, so the camera and all controls are accessible. Opinion is divided about the merits of this case when the camera is being used. It is good protection when carrying the camera or keeping it handy in car or plane.

is cheap insurance.

TESTING YOUR CAMERA

Occasionally, you should test your camera without shooting a test roll—using your eyes, ears and fingers to search for unusual indications. There are four things to check: The lens, the camera mechanism, the viewing system and the exposure-measuring system. Here are some simple checks you can do without film in the camera.

Operate the Film-advance Lever and trip the shutter several times at each shutter speed. Listen to the sound and check the feel of the mechanism. You can hear a difference in the longer shutter speeds below 1/125 or 1/60. Sometimes it's useful to compare the sound made by one camera to another of the same model.

Look into the viewfinder. If you see dirt particles in sharp focus, they are on the viewing screen. Blurry smudges will be on the mirror, on the lens, or on the surface of the viewing window. Remove the lens and look to see which. See cleaning instructions.

Dirt or smudges on the lens will affect the picture. Dirt on the mirror or in the viewing system is visible to your eye but not to the film.

To check the lens aperture mechanism, set it to *f*-11 or *f*-16, look into the viewfinder and operate the Stopped-Down Lever. The image should darken, indicating that the lens aperture and the stopped-down mechanism are both working. Hold the Stopped-Down Lever toward the lens, or lock it, and rotate the aperture ring on the lens to all *f*-numbers. You should see a different brightness at each *f*-stop.

Another way is to open the back of the camera, set shutter speed to B, trip the shutter and hold the shutter button down or lock it down. Hold or lock the Stopped-Down Lever toward the lens and then rotate the aperture ring on the lens. Look into the back of the camera and you should see the aperture changing size.

You can see the focal-plane shutter work by operating the camera at different shutter speeds with the back open.

You can check operation of the pins and levers on the back of the lens as described in Chapter 14.

EXPOSURE TESTS

Without film, you can make fairly accurate tests of the exposure-measuring system. There are two things to check: Is the exposure reading accurate? Is it consistent at different apertures and shutter speeds?

To check for accuracy, remember that exposure for a scene illuminated by direct sunlight should use a shutter speed which is the reciprocal of film speed, with the aperture set at *f*-16. Stand with the sun behind you, focus on the distant horizon and balance the exposure display in the viewfinder. If you are using 125 film speed, shutter speed should be 1/125 second. Try it at several different film-speed settings.

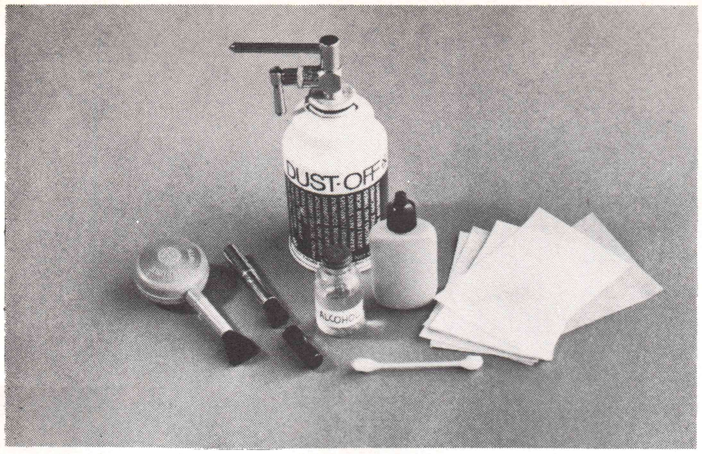
The amount of sunlight is greatly influenced by atmospheric conditions and time of day, so if your reading is not exactly as above, but is consistent at different film speeds, metering accuracy is probably OK.

Another check is to focus on a blank wall, balance the exposure display and then try different combinations of *f*-stop and shutter speed which *should* give the same exposure. For example, if the exposure display is balanced at *f*-4 and 1/125, it should also balance with one step larger aperture and one step shorter time—*f*-2.8 and 1/250. If the exposure measurement is consistent over a range of different combinations, metering accuracy is probably OK.

With film in the camera, a good test of exposure accuracy is to photograph an 18% gray card or any other medium-toned surface. Use slide film. After processing, compare the *projected* slide to the original subject. A check on consistency is to photograph the same surface at different combinations of *f*-stop and shutter speed. The resulting slides should all look the same.

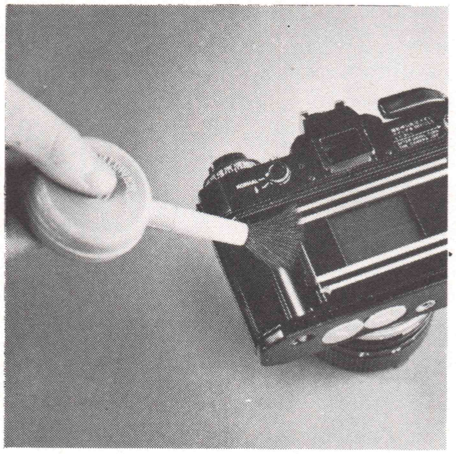
If you have access to another camera of the same model, you can compare readings of the same subject. They should agree within a half-step. Some photographers get carried away with accuracy and expect everything to be dead accurate. It isn't and it doesn't have to be. The international standard for camera exposure requires accuracy within one-half step. That means exposure is closer to what the camera controls say than to the next higher or lower step. Besides that, there are tolerances or variations in developing, printing, projection-lamp brightness, and also in film emulsions. For most photographers, the most critical exposure is for color slides and they will tolerate a half-step either way.

I don't recommend sloppy camera work, but I do recommend making the final judgment on results—the picture—rather than hair-line positioning of the meter needle.

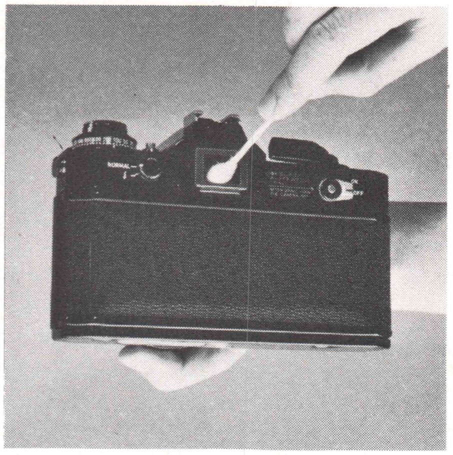


You don't need everything shown here but you do need some way to make a jet of air, lens-cleaning fluid, lens-cleaning tissues and *two* soft brushes.

"Canned air" is fine for blasting dirt out of corners and crevices. Be careful using it near the focal-plane shutter or you may blast it out too.



Blower brushes dislodge dirt particles two ways. Try a squirt of air first. Don't use the same brush to clean camera body and lens surfaces.



A cotton swab moistened with lens-cleaning fluid is a good way to get the viewing window clean.

KEEP IT CLEAN

Clean-up items are simple and inexpensive. You need some way to make a jet of air to blow dirt particles off the surface of the lens and from inaccessible corners of the camera. You can buy pressurized cans of air, use a rubber-bulb ear syringe available at pharmacy counters, or a combined squeeze-bulb blower and soft brush obtainable at camera shops.

To clean the camera body you need a soft cloth and a brush. To clean lens surfaces, you need another soft brush. Do not use the same brush on camera body and lens glass surfaces.

Lens-cleaning brushes are camel hair or equivalent in softness. Some come with a cover to keep them clean between uses. If yours doesn't have a cover, store it in a small plastic bag so it doesn't pick up grit in your gadget bag.

You need a pack of lens-cleaning tissue labeled for camera lenses—*not eyeglass lenses!* The eyeglass type is usually impregnated with silicone which leaves a film that is fine for your specs but not for your lenses. Don't use any kind of tissue except lint-free lens-cleaning tissue. Don't use nose-blowing tissue or bathroom tissue no matter how soft the advertising claims they are.

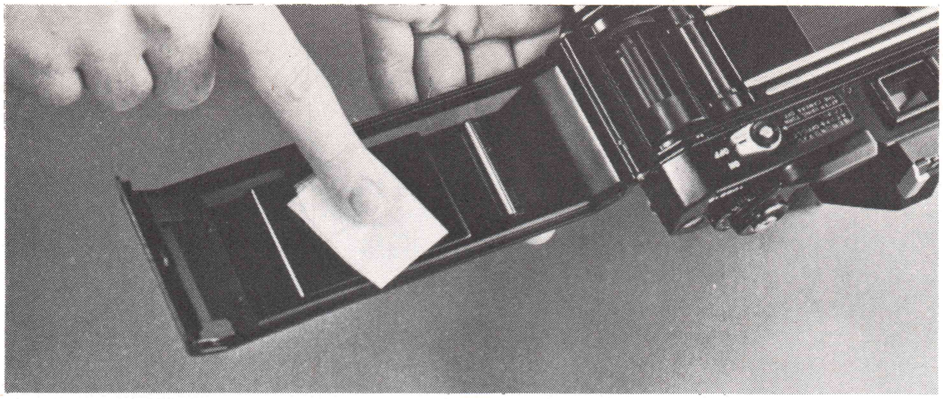
Get a bottle of rubbing alchohol at the drug store or a small bottle of lens-cleaning fluid at your camera shop. Cotton swabs on a stick, such as Q-Tip brand, are handy to have.

TO CLEAN THE CAMERA BODY

Use a soft cloth to clean the exterior. Use a brush to clean the interior, aided by a squirt of air if needed. Occasionally, dampen a lens tissue or cotton swab with alcohol or lens-cleaning fluid and clean the film guide rails in the body and the pressure plate on the back cover.

Precautions: Do not touch the mirror. If there is dust on it, it's OK to blow it off or brush it off lightly using your lens-cleaning brush. If you can't get it clean with gentle blowing and brushing, have it cleaned by a service agency.

Don't touch the bottom side of the viewing screen. You can clean the top side of the removable viewing screens used in the F-1 as you would clean a lens, but use only air and a soft brush on the bottom side so you don't damage the screen.



Use lens tissue or a clean soft cloth to remove dirt from pressure plate, rollers and film-guiding rails.

Be very gentle with the focal-plane shutter. A strong blast of air may blow it out of its guides or otherwise damage it. Gentle air pressure and light brushing will remove dust particles.

Most of this is just common sense. You can tell by looking at a focal-plane shutter that you shouldn't poke at it.

The viewing window will get dirtier quicker than any of the other optics. First blow away dirt particles, then use a tissue or cotton swab moistened with lens fluid to gently clean the glass surface.

CLEANING LENSES

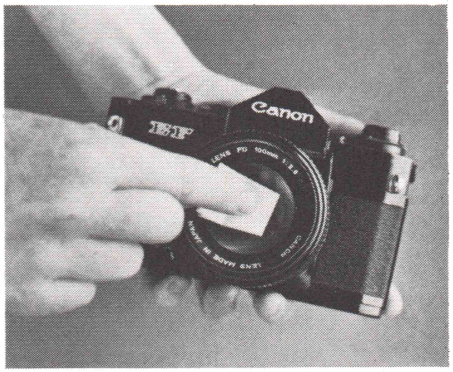
The barrel and exterior mechanical parts of a lens are cleaned with cloth and brush, same as the camera body.

The front and back glass surfaces should be cleaned infrequently and with great care to avoid scratching the surface. First, blow away all dirt particles. Then blow them away again. If the surface looks clean, stop right there. If not, brush gently away from the surface of the lens, trying to lift off dust particles.

If there are visible smears on the lens glass that the blower and brush won't remove, moisten a piece of lens tissue with cleaning fluid using only one or two drops of fluid. Don't get it soaking wet. Start at the center of the lens and work to the edge with circular motions, using the moistened lens tissue very gently. Think about *lifting off* the smear, rather than wiping it off.

Most lenses are cleaned much too often by their owners. There's no firm rule about how often, but if you clean your lens every day or every week, you are probably overcleaning it and risking surface damage.

Precautions: Never apply lens-cleaning fluid directly to the surface of a lens. Put a drop or two on tissue and use the dampened tissue to moisten the surface of the lens. An excess of fluid on the lens may seep around the edge of the glass and get between the lens elements, inside the lens barrel.



To clean lenses, first blow dirt away. Apply a drop or two of lens-cleaning fluid to lens-cleaning tissue—*never directly on the lens surface*—use tissue gently, working from center of lens to edge.

On lenses with a movable rear element, set the lens to infinity and the rear element will be closest to the back of the lens and easiest to clean.

Don't clean the rear surface just because you are cleaning the front surface. The rear surface should rarely get dirty and should rarely be cleaned beyond a squirt of air.

STORING YOUR CAMERA

If you will not be using the camera for several months, remove the battery or batteries, wrap the camera in a clean dry cloth and store it in a plastic bag along with a packet of silica gel or some other dessicant to absorb moisture.

TROUBLES THAT AREN'T SERIOUS

New owners of Canon equipment sometimes think they have a problem but it turns out to be only an improperly set control or an improper procedure. Here are some little things you may encounter.

Lens doesn't stop down when you operate the Stopped-Down Lever. You may have mounted the lens with the Stopped-Down Lever locked in the stopped-down position. Remove the lens, put the lever in the normal position, remount the lens and it should be OK. On the EF camera, you probably haven't advanced the film. Operate the Film-advance Lever to bring an unexposed frame into place and the lens should function normally.

Lens doesn't "want" to mount on the camera. Check to see if you have the lens set for automatic and are trying to mount it on a non-automatic camera. If so, rotate the aperture ring to any *f*-number and the lens will mount. On early lenses which don't have the Mount-Lock Pin, it is possible to accidentally rotate the Breech-Lock Ring with the lens off the camera. This ring must be turned fully counterclockwise to mount the lens.

CANON FACTORY SERVICE CENTERS

JAPAN	Canon Inc. 9-9, Ginza 5-chrome Chuo-ku, Tokyo 104 Phone: 572-4251
U.S.A.	Canon U.S.A., Inc. 10 Nevada Dr. Lake Success, Long Island, NY 11040 Phone: 516-488-6700
	Canon U.S.A., Inc. 600 Third Ave. New York, NY 10016 Phone: 212-697-9720
	Canon U.S.A., Inc. 457 Fullerton Ave. Elmhurst, IL 60126 Phone: 312-833-3070
	Canon U.S.A., Inc. 123 Paularino Ave. East Costa Mesa, CA 92626 Phone: 714-979-6000
	Canon U.S.A., Inc. Los Angeles Service Station, 3407 W 6th St. Los Angeles, CA 90020 Phone: 213-487-3410
	Canon U.S.A., Inc. Bldg. B 2, 1050 Ala Moana Blvd. Honolulu, HI 96814 Phone: 808-524-0220
	Canon U.S.A., Inc. 776 Market St., San Francisco, CA 74102 Phone: 415-433-5640
	Canon U.S.A., Inc. 160 Peachtree St. N.W. Atlanta, GA 30303 Phone: 404-688-9000
CANADA	Canon Optics & Business Machines Canada, Ltd., 3245 American Dr. Mississauga, Ontario, L4V 1B8 Phone: 416-678-2730
	Canon Optics & Business Machines Canada, Ltd. 3070 Brabant Marineau Street, St. Laurent, Quebec, H4S 1K7 Phone: 514-334-0110
	Canon Optics & Business Machines Canada, Ltd. 735 Elmbridge Way Richmond, B.C., V6X 1B8 Phone: 604-273-0801
EUROPE, AFRICA AND MIDDLE EAST	Canon Amsterdam N.V. Gebouw 70, Schiphol Oost, Holland Phone: Amsterdam 020 17 3031
CENTRAL AND SOUTH AMERICA	Canon Latin America, Inc. P.O. Box 2019 Colon Free Zone, Republic of Panama Phone: 36660 2169 pa
SOUTHEAST ASIA	Canon Inc., Hong Kong Branch, 5th Floor 2-6, Fui Yiu Kok Street Tsuen Wan, New Territories, Hong Kong

Film-advance Lever won't advance the film. Maybe you've shot the last frame. If you force it, you can pull the taped end of the film free of the spool in the cartridge. Then you can't rewind and must unload the camera in total darkness to save the film.

Exposure meter doesn't work. Is it turned on? Maybe the battery is dead—they fail suddenly. Make a battery check. Clean the battery by rubbing both sides with a clean cloth. If the camera is an EF, the exposure meter is dead when the CAT switch is set for flash.

Viewfinder is dark. Is the lens cap off? Is the mirror locked up?

Don't force anything. If something doesn't work right and you can't find the cause by observation or simple tests, don't use force! If you do, you may convert one problem into several problems—very suddenly!

HOW TO GET IT FIXED

There are three kinds of repair facilities. Canon Factory Service Centers are part of the Canon organization, operated by Canon employees. Naturally they have complete factory data and spare parts. Canon maintains a supply of spare parts for ten years after a camera model or lens was manufactured.

Canon Authorized Service Facilities are independent repair shops which are qualified to work on Canon equipment. They have factory service information and spare parts.

Other independent service and repair shops are not authorized to work on Canon equipment even though they may be competent and they may be authorized service locations for other brands.

If you mail your camera to a Factory Service Center or Authorized Service Facility, be sure to pack it carefully with padding between the camera and the carton. It's a good idea to save the original packing for this purpose, even though you may never have to use it. Enclose a letter describing the trouble. If you have slides or prints showing the trouble, enclose them also.

WARRANTY SERVICE

The Canon warranty is not reproduced here because it may differ to accommodate laws in various countries. In general, the currect warranty is for one year from date of purchase and covers all defects in material and workmanship. Such defects will be repaired free of charge—except for handling and forwarding—by Canon Factory Service Centers.

Read the warranty card packed with Canon equipment. There are conditions and requirements not mentioned here.

OUT-OF-WARRANTY SERVICE

When a year has gone by, your warranty has expired. You can have your camera equipment serviced at standard charges by Factory Service Centers or Authorized Service Facilities.

A list of Authorized Service Facilities around the world is available from your Canon dealer or your nearest Factory Service Center.

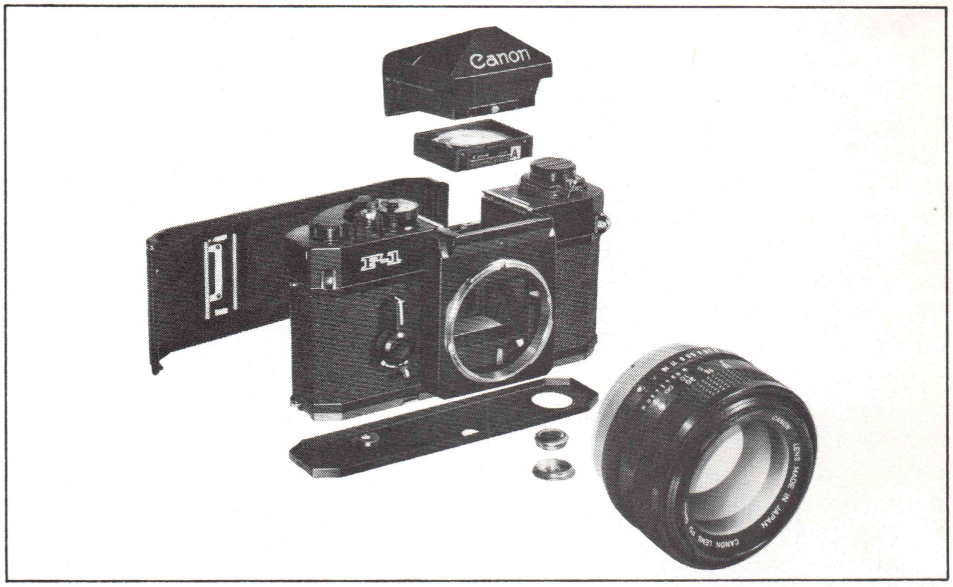
For out-of-warranty service, you can either authorize immediate repair or ask for an estimate of cost and time required.

FREE CAMERA INSPECTION

Local dealers of Canon cameras offer camera clinics periodically. These are staffed by qualified Canon technical representatives and technicians who will be glad to inspect and check your camera free of charge. They can give you good advice on equipment and its use, problems you may encounter, and show you the latest new developments in equipment. In major cities, these clinics are offered about twice a year. Watch your newspaper and stay in touch with your local dealer.

18

THE CANON SLR SYSTEM


A multitude of system accessories is available for the F-1. The bottom cover comes off to attach a motor drive, back cover comes off to attach the 250-frame film chamber, pentaprism is removable to interchange focusing screens or use accessory focusing and metering devices, and of course the lens comes off so you can use different lenses.

System is a word you often see in camera advertising. It means a camera and a wide variety of lenses and accessories which adapt the camera to do a lot of different things—such as take pictures in low light or with very high magnification—use a motor drive and take pictures unattended, and the like.

The definitive "system camera" in the Canon line is the F-1 because more of the available accessories fit the F-1 than any other model. However, some accessories fit all models, so *every* Canon SLR is a system camera to some degree.

In choosing a camera, it's worthwhile to have the system idea in mind because it forces you to think about what you may wish to do with your camera and then be sure the camera you buy will allow you to do it.

If you are just starting to use an SLR, it's hard to know what you will be doing with it in a year or two and it's hard to predict what you will be interested in photographing. People tend to develop specialties and photographic preferences which influence their choice of equipment and how they use it. If you haven't experienced using a very long lens, or a wide angle, or macro photography, or shooting at night, or any of thousands of things imaginative people find to do with cameras, then you can't really know if you like to do that or not.

The best guide is your own experience and success as a photographer. Without that, here's an idea I think will help. I like certain types of pictures better than others—whether I took them or not. When I make a good picture of any kind I am pleased. When I make a good one of a type I particularly appreciate, I get all enthused about it and go around making people tell me it's an outstanding photo. Naturally I ended up choosing equipment and working on techniques so I could make pictures of the types I like best. Probably the same thing will happen to you.

Therefore you can get some advance indications of equipment you will want to own just by looking at pictures in books and magazines; photos taken by your friends; and, of course, your own photos taken with whatever kind of equipment you've been using.

For a beginning, equip yourself to make photos you will like and your friends will enjoy seeing.

To help you do that, this chapter has descriptions of current and recent Canon SLR cameras, all of the major accessories in common use, and minor or incidental accessory items. Some operational details and procedures not covered earlier are also included here.

THE F-1 CAMERA

Because of the wide variety of accessories for the F-1, it offers the greatest range of capabilities among the various Canon cameras.

Metering is semi-spot with the metering area shown by a rectangle on the screen and a match-needle display. The meter sensor is cadmium sulfide. All cadmium-sulfide sensors have two characteristics which you should be aware of. When exposed to bright light, they have a "memory" which causes erroneous readings if exposed to dim light immediately afterwards. The reading error can be avoided by waiting a couple of minutes. When used to measure exposure in *very* dim light, they react slowly. If the meter needle seems to be drifting, it has not yet reached its final position on the scale. When the exposure controls are set beyond the coupling range of the meter, the entire exposure display turns red.

Light to illuminate the exposure display in the viewfinder is taken from a small window on top of the camera body, just to the left of the pentaprism. On all other Canon SLR cameras, light coming through the lens illuminates the exposure display. With any camera which uses ambient light to illuminate the display, shooting in dim light makes it difficult to read the display. Flash Coupler L solves this problem on the F-1 with a small lamp which can be turned on to throw light into the window on the camera and illuminate the display.

Metering is open-aperture or stopped-down when using FD lenses; stopped-down when using FL or other lenses and when using accessories between lens and camera such as extension tubes or a bellows. The Stopped-Down Lever closes lens aperture to whatever is selected at the lens; also raises the mirror; and also serves as the self-timer control which introduces a delay of about ten seconds between depressing the shutter-release button and the actual opening of the shutter. The associated Lever Lock locks lens aperture in the stopped-down position and also locks the mirror in the raised position.

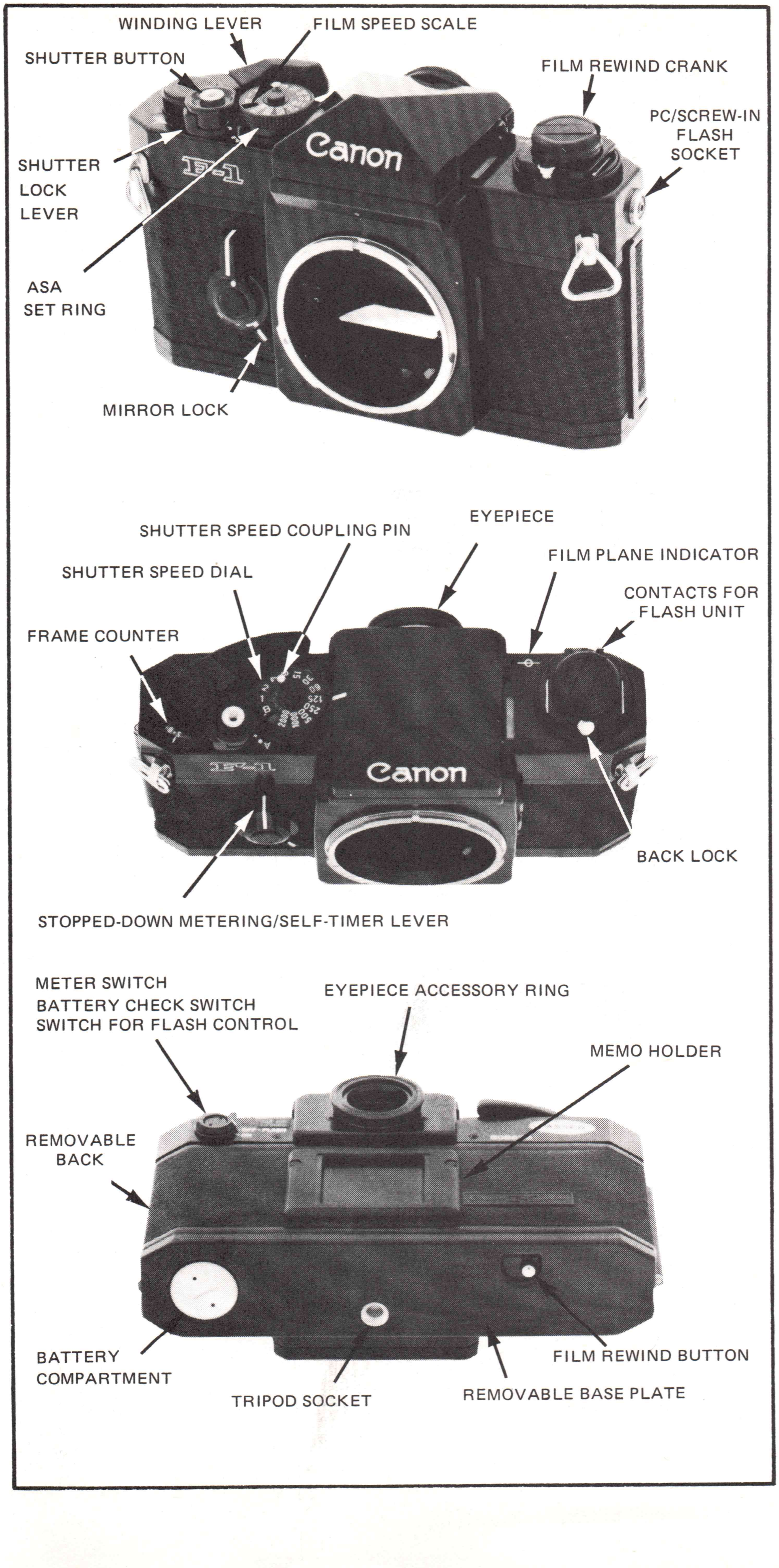
The titanium focal-plane shutter travels horizontally with a maximum speed of 1/2,000 second. For a complicated mechanical reason, shutter speed *may not* be accurate at 1/2,000 when the mirror is locked up. Therefore Canon recommends not using 1/2,000 when the mirror is locked up.

To clear the back of the lens when the mirror swings up, the bottom part of the mirror has the corners cut off and is a little shorter—that is, there is less mirror below the middle of the lens than above. With very long lenses and with extension tubes between camera and lens, this may slightly darken the top of the image you see in

F-1 SPECIFICATIONS

Type: 35mm single-lens reflex camera with focal-plane shutter, quick-return mirror and Canon Breech-Lock lens mount.
Standard Lenses: Canon FD 55mm *f*-1.2 S.S.C., Canon FD 50mm *f*-1.4 S.S.C., Canon FD 50mm *f*-1.8 S.C.
Interchangeable Lenses: Canon FD series: Full-aperture metering with automatic diaphragm operation. FL series: Stopped-down metering with automatic diaphragm operation. R series: Stopped-down metering with manual diaphragm operation.
Viewfinder: Removable eye-level pentaprism. Interchangeable with Servo EE Finder, Booster T Finder, Speed Finder, Waist-Level Finder. Standard eyepiece is –1 diopter.
Viewfinder Information: Meter and aperture needles, red signal indicates when outside of meter-coupling range, fixed dot for stopped-down metering and battery check, shutter-speed indicator, depth-of-field preview, over and underexposure warning marks.
Viewfinder Attachments: Angle Finders A2 and B, Magnifier R, Eyecup R, Rubber Eyecup, 10 Dioptric Adjustment Lenses from -4 to +3 diopters.
Focusing Screen: Screen E, page 149: Center split-image/microprism focusing aid surrounded by matte screen. 8 other screen types are interchangeable. Screen A standard on earlier models. Metering beam-splitting condenser.
Field of View: 97% of actual picture area. 0.77x magnification with standard 50mm lens at infinity.
Mirror: Quick-return type. Can be locked in up position.
Shutter: Titanium focal plane, horizontal movement. Speeds 1 sec. to 1/2000 sec. X contact at 1/60. sec. Shutter-release button can be locked.
Shutter-Speed Dial: Shutter speeds and ASA film speeds, two coupling pins provided for setting attachments.
Self-Timer: Built-in. Stopped-Down Lever sets approx. 10 sec. time delay for shutter. Activated by shutter release.
Film-Speed Range: ASA 25–3200. Earlier models have ASA 25–2000.
Exposure Meter: Built-in match-needle type for full-aperture metering with FD lenses. Coupled to shutter speeds, film speeds and *f*-stops. CdS photocell provides semi-spot metering of central 12% of picture area. Stopped-down metering is done with Meter Index and lockable Stopped-Down Lever.
Exposure-Meter-Coupling Range: With ASA 100 film, EV 2.5 to EV 18 (*f*-1.2 at 1/4 sec. to *f*-11 at 1/2000 sec.).
Battery: One 1.3V M20 (625) battery.
Flash Synchronization: FP and X contacts. X (electronic flash) sync at 1/60 sec. or slower. FP flashbulbs sync at 1/125 to 1/2000 sec. and 1/30 sec. or slower. M, MF flashbulbs sync at 1/30 sec. or slower.
Flash Connections: Through Accessory Shoe Flash Couplers D and L. PC socket on camera body.
Canon Auto Tuning (CAT) System: Uses Flash Coupler L, Flash Auto-Ring A2 or B2 and Speedlite 133D with FD 50mm *f*-1.4 S.S.C., FD 50mm *f*-1.8 S.C., FD 35mm *f*-3.5 S.C. or FD 35mm *f*-2 S.S.C. lenses.
Film Loading: Uses multi-slot take-up spool. Accepts any standard 35mm film roll in cartridge.
Film-Advance Lever: Single or multiple-stroke operation, 139° throw. Lever standoff is 30°.
Film Rewind: Uses rewind button and crank.
Frame Counter: Counts every full stroke of film-advance lever from S-1-38, including those for multiple exposures. Automatically resets to S when back cover is opened.
Multiple Exposure: Use procedure detailed on pages 150, 151.
Back Cover: Removable to allow use of Film Chamber 250.
Bottom Cover: Removable to allow use of Motor Drive.
Dimensions: 146.7 x 99.5 x 49.5mm (5-3/4" x 3-15/16" x 1-15/16").
Weight: Body only: 820g (1.8 lbs.). With FD 50mm *f*-1.4 S.S.C. lens: 1,205g (2.66 lbs.).

Specifications subject to change without notice.


WINDING LEVER
FILM SPEED SCALE
SHUTTER BUTTON
FILM REWIND CRANK
PC/SCREW-IN FLASH SOCKET
SHUTTER LOCK LEVER
ASA SET RING
MIRROR LOCK
Canon
F-1
EYEPIECE
SHUTTER SPEED COUPLING PIN
FILM PLANE INDICATOR
SHUTTER SPEED DIAL
CONTACTS FOR FLASH UNIT
FRAME COUNTER
BACK LOCK
STOPPED-DOWN METERING/SELF-TIMER LEVER
METER SWITCH
BATTERY CHECK SWITCH
SWITCH FOR FLASH CONTROL
EYEPIECE ACCESSORY RING
MEMO HOLDER
REMOVABLE BACK
BATTERY COMPARTMENT
TRIPOD SOCKET
FILM REWIND BUTTON
REMOVABLE BASE PLATE

the viewfinder. There is no darkening of the image on film, and the darkened area on the viewing screen is outside the metering rectangle so there is no effect on exposure.

MULTIPLE-EXPOSURE PROCEDURE

Current production cameras (with ASA 3200 film speed setting) use this exposure procedure:

Make exposure #1. Depress the film-rewind button on the bottom of the camera. It will lock in place so you don't need to hold it depressed. Use the film-advance lever to advance the next frame. Make exposure #2. Continue that procedure for as many exposures as desired on the same frame.

Naturally you will have remembered to make exposure settings suitable for multiple exposures. The frame counter counts movements of the film-advance lever rather than actual movement of the film, so it will show a higher number even though the same frame is still in place.

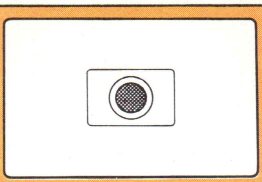
MOTOR DRIVE FOR THE F-1

Most professional photographers of sports and subjects in action use a motor-drive camera as do glamour photographers, portrait photographers and many others.

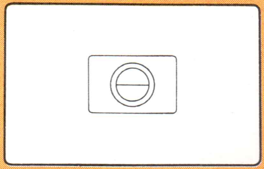
Motor drive is also useful when the presence of the photographer is inconvenient or dangerous, and cases where an event is going to take place but the exact time cannot be forecast. These cases call for unattended photography, remote control, or devices to start camera operation when the event to be photographed begins happening.

For most motor-drive applications, the Servo EE Finder is also useful for automatic exposure control.

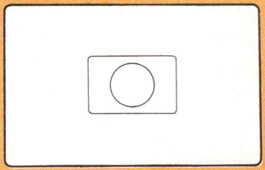
Canon's Motor Drive MD and Motor Drive MF, have more similarities than differences. Both use two internal motors—one to advance the film and the other to trip the shutter. Both allow single-shot operation, making one frame



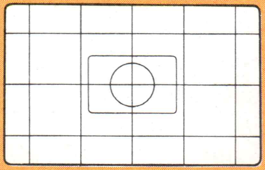
FOCUSING SCREEN A (Microprism) Suitable for a wide range of focal lengths and apertures. Surrounding the circular microprism area is a matte screen which can be used for focusing with any lens.



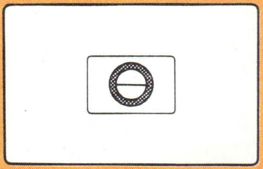
FOCUSING SCREEN B (Split-Image) Biprism designed for large and medium size maximum apertures. Surrounding the matte screen can be used for focusing with any lens.



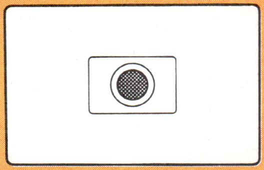
FOCUSING SCREEN C (Matte Surface) Suitable for general photography and critical focusing—circular central area is matte with a fine texture. Recommended for long telephotos and super telephotos.



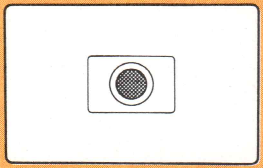
FOCUSING SCREEN D (Matte Surface with Grid) Identical to C except a grid has been added for copying documents, architectural photography, and similar uses. Recommended for use with TS 35mm *f*-2.8 lens.



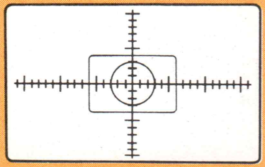
FOCUSING SCREEN E (Split-Image/Microprism) A general-purpose screen combining the two most-used focusing aids.



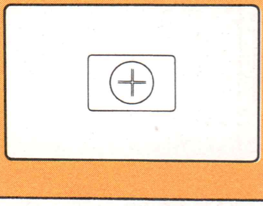
FOCUSING SCREEN F (Microprism for large-aperture lenses) The microprism angles in this screen work best with lenses having maximum aperture of *f*-2.8 and larger. With lenses of smaller maximum aperture, microprism may black out. The surrounding matte screen can be used with any lens.



FOCUSING SCREEN G (Microprism for small-aperture lenses) For use with lenses having maximum aperture of *f*-3.5 through *f*-5.6 with high acuracy and no blackout. The surrounding matte screen may be used for focusing with any lens.

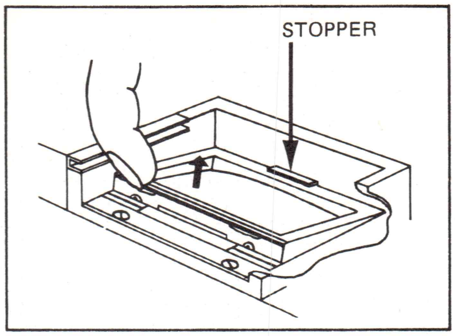


FOCUSING SCREEN H (Matte/Scale) Central circular area is fine-matte for critical focusing. Horizontal and vertical scales are useful for scientific, macro, copying and architectural photography.



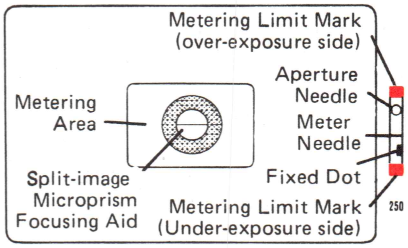
FOCUSING SCREEN I (Double Cross-Hair Reticle) Recommended for extremely high magnifications. Subject is in focus when changing the position of your eye does not cause cross-hairs to move in relation to subject.

There are 9 interchangeable focusing screens for the F-1, each tailored for a different shooting condition as described in this table. Screen A was standard. In camera production beginning late 1976, Screen E became standard.



When installing or removing focusing screens in the F-1, be careful to lift the back of the screen high enough to avoid scratching against camera body.

F-1 VIEWFINDER INFORMATION



each time the Motor Drive Button is depressed, or continuous operation when a switch is turned from S to C to change from single-shot to continuous.

When operating at maximum speed, the MD unit exposes 3 frames per second; the MF unit exposes 3-1/2 frames per second. Both are battery-powered and both supply battery power to a Servo EE Finder. Both can drive the camera with a conventional 36-exposure film cartridge in the camera. Both can be used with the accessory Film Chamber 250 Set which holds 250 frames of 35mm film. It replaces the F-1's back-cover.

Both have frame counters for use with 36-exposure cartridges. These can be preset to any number you select and they count down to zero as frames are exposed. Preset the counter to 6 and the motor drive will expose 6 frames and

COUPLING RANGE OF BUILT-IN EXPOSURE METER

FILM SPEED	SHUTTER SPEED											
ASA 25	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000
ASA 50	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000	..
ASA 100	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000	...	...
ASA 200	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000	...	...	...
ASA 400	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000	...	...	...	...
ASA 800	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000	...	...	...	...	...
ASA 1600	1/60	1/125	1/250	1/500	1/1000	1/2000	...	...	...	...	...	...
ASA 3200	1/125	1/250	1/500	1/1000	1/2000	...	...	...	...	...	...	...
Minimum *f*-stop	f/22	f/22	f/22	f/22	f/22	f/22	f/22	f/22	f/16	f/11	f/8	f/5.6

F-1 FLASH SYNCHRONIZATION

TYPE		SHUTTER SPEED
CAT Automatic		1/60
Canon Speedlite (Non-automatic)		1/60 or slower
Other Electronic Flash		1/60 or slower
Flashbulbs:	FP	1/125 or faster, and 1/30 or slower
	M	1/30 or slower
	MF	1/30 or slower

ASA 25 • • 50 • • 100 • • 200 • • 400 • • 800 • • 1600 • • 3200

(32) (40) (64) (80) (125) (160) (250) (320) (500) (650) (1000) (1250) (2000) (2500)

There isn't enough room on the film-speed dial to show all settings. Figures in parentheses appear as dots on the dial.

then shut off. If you set it to 36 with a new 36-exposure cartridge, it will always show the number of frames remaining whether you are making single shots or short bursts with manual control of duration. If you set the counter for more frames than there are left in the cartridge, it will run through the actual available number of frames of film and then click on down to zero. When the 250-frame chamber is used, the frame counter on the motor drive is turned off and frames are counted by the Film Chamber 250.

Both have self-timers (intervalometers) to shoot at slower speeds than the maximum rate. The intervalometer is built into the MD; it's an accessory on MF. The MD allows exposures ranging from 3 each second to one every sixty seconds. The MF range is from 2 each second to one every three minutes. In both units the timer switch has a setting labeled T.OFF, which means Timer Off. This setting is used for continuous motor drive at maximum speed and also for single-shot operation because you don't want an internal-delay mechanism interfering when you are firing each shot with your finger.

Neither of the units can work faster than the camera shutter speed will allow. That is, you can't make one-second exposures at the rate of 3 per second. Both units have a table engraved on the back which gives permissible shutter speeds and motor-drive-control settings.

With all these similarities, how do you choose the right motor-drive unit for your application?

If you expect to have special applications frequently requiring remote control, consider the MF first. It has a built-in electrical relay which starts and stops the motor drive and is, therefore, a little more suitable for special devices used for remote control. If your need for remote control is never more complicated than

Canon offers two motor drives for the F-1. This is Motor Drive MF used with the Servo EE finder, which makes the camera self-contained and fully automatic.

John Wall demonstrates F-1 with Motor Drive MF, Servo EE Finder and 85-300 zoom lens—a good combination for fast-moving sports and action photography. All you do is focus and press the button on the motor drive. Maximum film capacity with this setup is 36 exposures.

MOTOR DRIVE MF SPECIFICATIONS

Type: Fits F-1 only. Power drive system. Fits in place of the bottom cover.

Construction: Two-motor system with built-in motors for film drive and shutter release. Uses an electromagnetic relay circuit-control system.

Sequence rate: 3.5 frames per second at maximum speed.

Mode of operations: S (single frame), C (continuous run). Changed by a switch.

Coupling range of shutter: S: All shutter speeds from 1 to 1/2000 second, except "B." C: 1/60 to 1/2000 second.

Frame Counter: Manually set, it indicates the remaining number of frames and automatically stops at 0. When using the Film Chamber 250, set at F.C.

Grip: Contains battery. Detachable. When using the Film Chamber 250, remove the grip and connect it with the Connecting Cord for Grip MF.

Power source: Ten penlight (size AA) batteries.

Shooting capacity: 80 36-exposure rolls or more with manganese batteries.

Battery checker: Built into the grip with lamp indicator.

Shutter-release button: At the upper part of the grip. With cable-release socket and large button. Auxiliary cable-release socket on the side of the body.

Film Chamber 250: Can be used with this Motor Drive.

Film loading: Ordinary loading is possible with the Motor Drive MF attached.

Remote control: Various external-control devices are available, connected through the remote-control jack.

Size: Body — 153 x 51 x 23mm (6"x2"x9"). With grip — 179 x 120 x 63mm (7" x 4-3/4" x 2-1/2").

Weight: Body 650 gr. (1 lb. 7 oz.). With grip — 1070 gr. (2 lb. 3 oz.) including 10 penlight batteries.

Subject to change without notice.

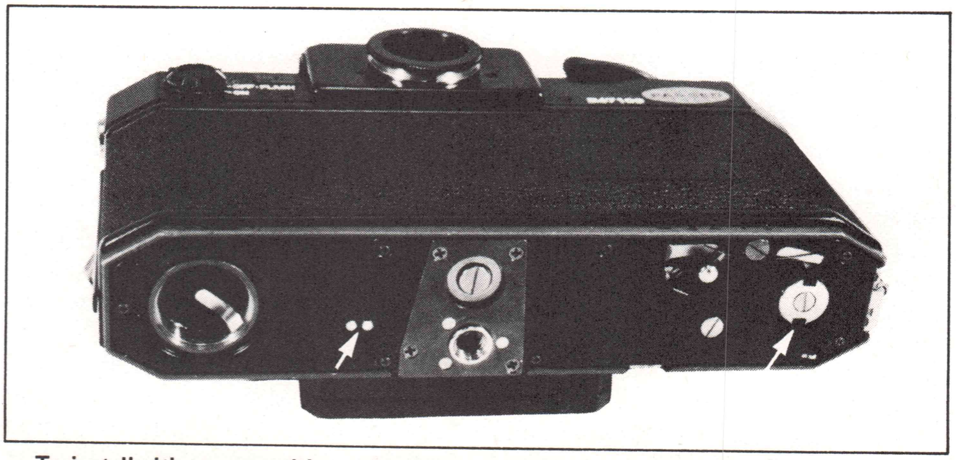
a push button or an intervalometer, the MF has no major advantage over the MD.

The MF is more convenient to hand-hold because it is one unit, entirely self-contained with batteries in the handle which power both the motor drive and a Servo EE Finder. But that only applies when you *don't* use the 250-frame chamber. To attach the Film Chamber 250 with MF motor drive, you must detach the motor-drive handle to make room for the large film chamber. Because the handle contains both the batteries and the control switch, it must be connected to the motor drive with an extension cord. If you are hand-holding, this is a disadvantage because you don't have a third hand for the detached battery case and control button.

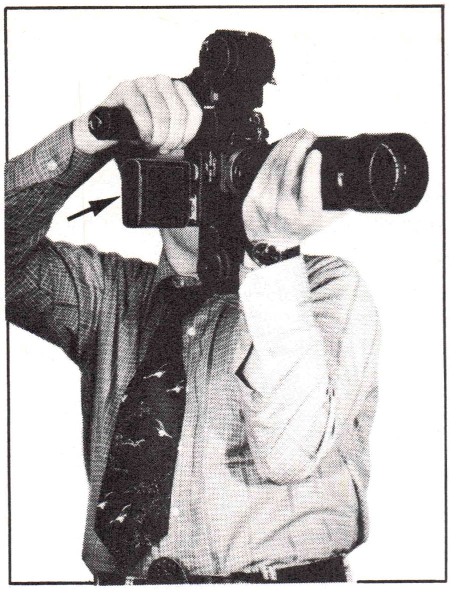
In cold weather, battery power is reduced if the batteries get cold. Detaching the battery case and keeping it in your pocket can be an advantage—particularly if the camera is on a tripod.

The MD can use either a separate battery case connected by an extension cord, or an attached battery case which becomes part of the unit. The separate battery case can supply power to motor-drive unit and a Servo EE Finder—through two separate cables. If you are hand-holding and using the Servo EE, you end up with a battery case on your belt and two coiled cables connected to the camera unit—a minor inconvenience. If the equipment is on a tripod it doesn't matter anyway.

For more convenient hand-holding with the MD motor drive, Battery Case D clips onto the bottom of the motor-drive unit, eliminating the connecting cable.



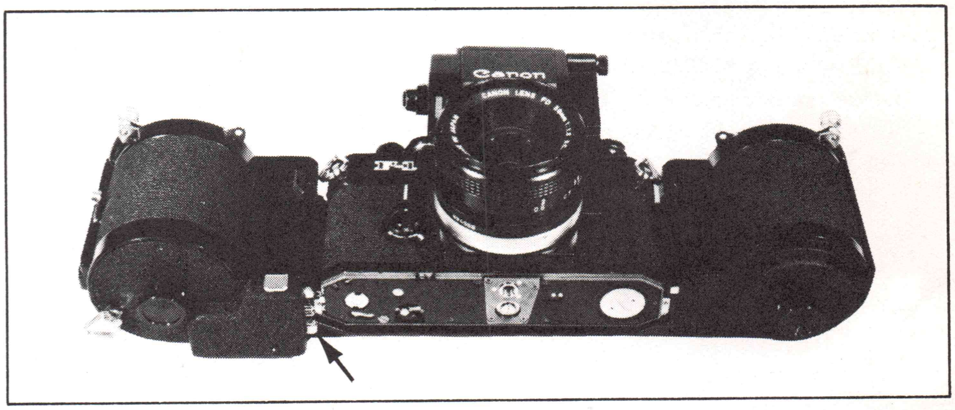
To install either motor-drive unit, unscrew battery cover, remove camera bottom. Bottom has been removed in this photo to show motor-drive coupler and connections (arrow). Replace camera battery and cover, then attach motor-drive unit.



John Wall demonstrates F-1 with Motor Drive MD, batteries in clip-on Battery Case D (arrow), Film Chamber 250, and zoom lens. With clip-on battery case, Motor Drive MD does not supply power to allow use of Servo EE Finder. Speed Finder is being used although you can't see it in this photo.

MOTOR DRIVE MD SPECIFICATIONS

Circuit Construction: 5 transistors, 2 diodes, 5 condensers, 1 SCR.
Shooting Intervals: 1/3 sec. to 60 sec./frame.
Timer Scale: 7-stage. "T.OFF", 0.5, 1, 2, 5, 10, 60 sec. Time allowance, ±12%.
Power Source: DC 15v. Canon NiCad Battery 500 FZ, or 10 penlight (size AA) batteries loaded in Battery Case and connected with Battery Connector MD.
Battery Check: By Battery Checker MD.
Photographing Capacity: NiCad Battery 500 FZ; 36 frames x approx. 80 rolls at full charge. Penlight batteries, Alkaline, 36 frames x 80 rolls or more. Manganese, 36 frames x 50 rolls or more.
Frame Counter: Counts the number of the unexposed frames. Automatically stops at "0".
Remote Control: Connect the Remote Switch MD to the terminal on the Battery Connector. Length of cord is 5 meters. An extension cord (10 meters) is available. Ultrasonic Remote Switch, Wireless Remote Switch, Parallel Switch Box, Extended-time Timer are under development.
Unmanned Photography: By coupling with Servo EE Finder.
Shutter Release Button: With cable release socket.
Size: 150 x 170 x 34mm (5-15/16" x 6011/16" x 1-5/16").
Weight: 720 grams (1.59 lbs.).
Accessories: Battery Case, Battery Connector MD, Remote Switch MD, Film Chamber 250, Film Loader 250, Film Magazine 250, Extension Cord MD, Case, Battery Magazine 15V, NiCd Battery 500 FZ, Battery Checker MD.



To use Film Chamber 250 with motor drive, attach Film Chamber first, then install motor drive. Takeup motor in Film Chamber receives electrical power from motor drive unit through contacts (arrow).

It doesn't have enough power to supply the Servo EE Unit, but it makes a compact and handy motor-drive camera if you don't need automatic-exposure control. If you use this combination to shoot action, consider replacing the pentaprism with the Speed Finder for easier viewing.

One choice is obvious: For hand-holding with the 250-frame, film chamber, use the MD motor drive. For hand-holding without the 250-frame chamber, use the MF.

FILM CHAMBER 250 SET

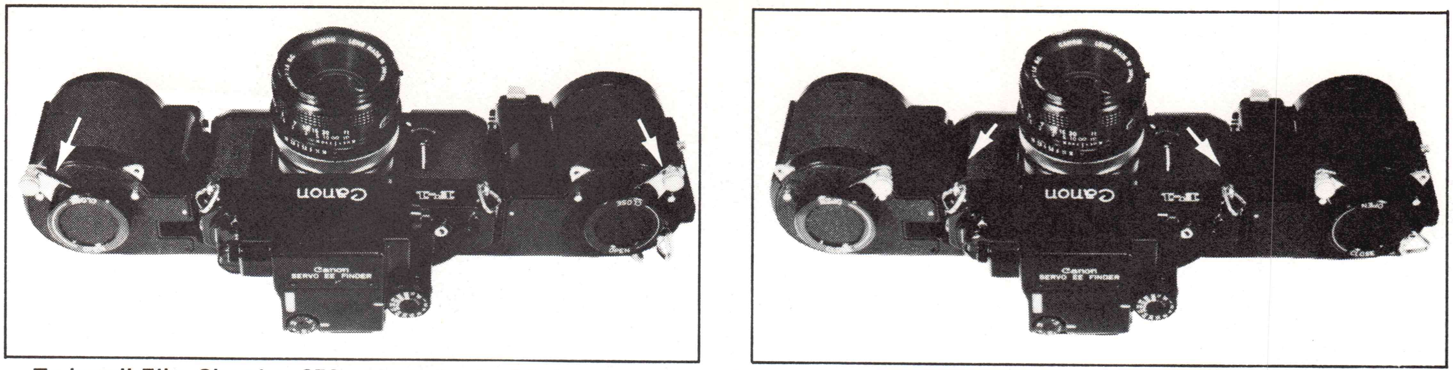
This consists of Film Chamber 250 and a set of two Film Magazine 250's, special film cartridges large enough to hold 250 frames. You also need Film Loader 250 to load the film cartridge (magazine) by spooling the correct length of film from a bulk roll. Not all types of film are available in bulk.

Each special film cartridge has three parts: A spool for the film, an inner case and an outer case. The two cases each have a wide slot. The outer case rotates around the inner case so the slots are not aligned and this blocks light entry. There is space between inner and outer case for the film to pass through.

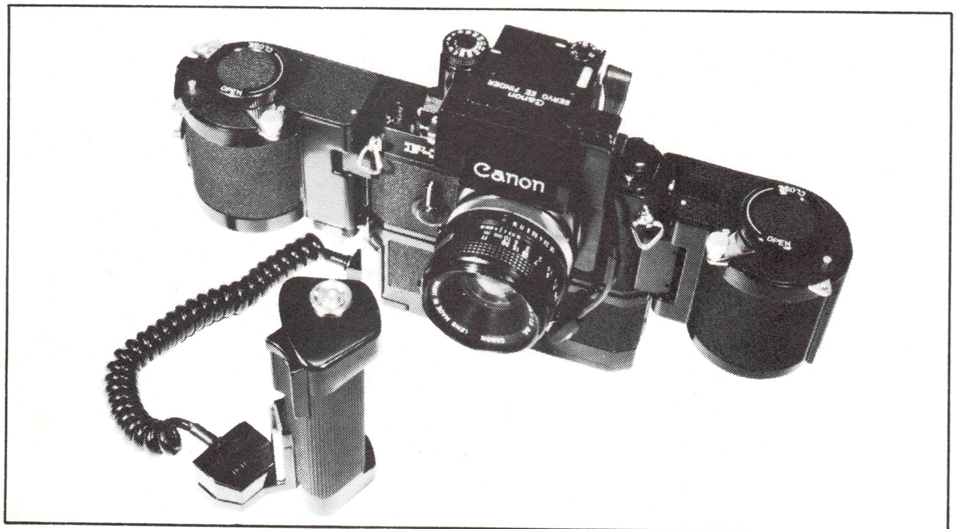
Loading the film cartridge is a darkroom operation. The bulk roll of film is placed on the feed shaft of the Film Loader 250, the free end is trimmed at an angle and passed over a sprocket which counts frames as you load, then placed in a slot in the film spool on the take-up shaft of the loader. Set the film counter for the number of frames you wish to load—up to 250—and it will count down to zero as you turn the take-up handle. The handle stops when the frame counter reaches zero.

The Film Chamber is opened in daylight—but not direct sunlight—a full cartridge is loaded into the feed side; film is pulled across and the end inserted into the spool of the take-up cartridge. This cartridge is assembled and dropped in the Film Chamber.

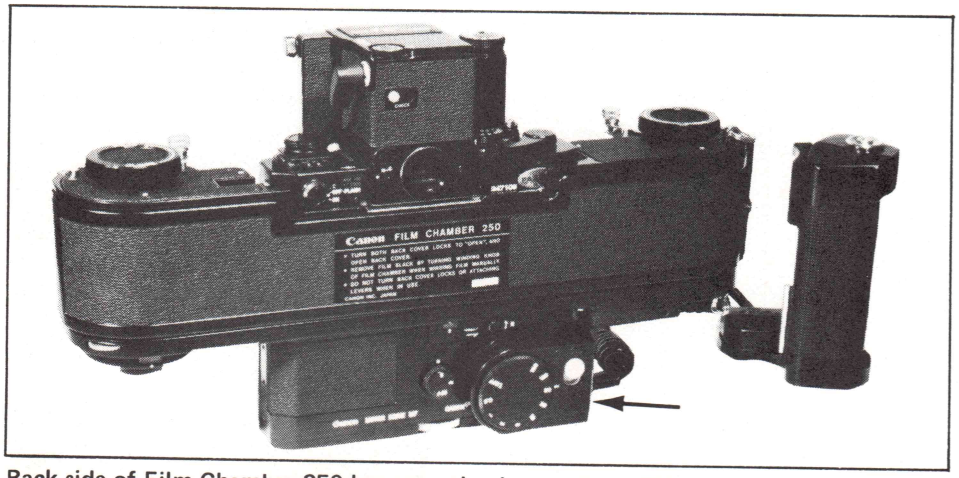
The Film Chamber is installed on the F-1 after removing the back of the camera by its spring-loaded hinge pin. After the Film Chamber is installed, then attach the motor



To install Film Chamber 250, remove back of F-1 and set camera into place on Film Chamber. Flip the camera-strap attachment rings up and out of the way as shown. Then move two Camera-Holding Levers (arrows in left photo) toward camera. This moves Camera Holders (arrows in right photo) so they clamp camera body securely in place.



To use Film Chamber 250 with Motor Drive MF, you must remove the motor-drive handle (Grip MF) which is also the battery case. Connection is made by Cord MD.



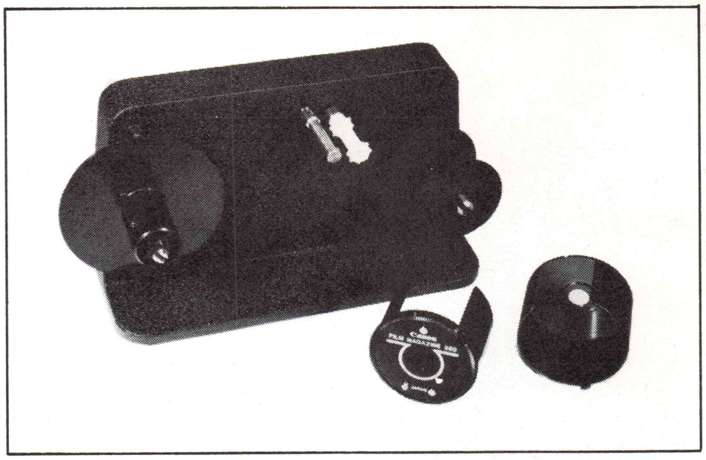
Back side of Film Chamber 250 has operating instructions. This combination—F-1, Motor Drive MF, Film Chamber 250, and Servo EE Finder can be used for unattended photography with choice of several items to control motor drive. Here, Interval Timer L (arrow) is attached to motor-drive unit to take single frames at time interval selected by dial on timer.

drive. The frame counter and automatic cut-off feature of the motor drive is disabled by setting it to F.C. which transfers the frame-counting function to the Film Chamber 250. The frame counter on the Film Chamber is set to the number of frames you have loaded—normally 250—and it will count down to zero. When the film runs out of the feed spool in the film chamber a built-in switch automatically turns off the motor-drive unit.

When the Film Chamber is not installed on a camera, the film between cartridges is exposed to light and the only thing that keeps light out of the cartridges is rotation of the cartridge outer case so the slots don't line up. This rotation is controlled by two knobs, each marked OPEN and CLOSE, on the Film Chamber ends. The nomenclature may be confusing unless you remember that it refers to the Film Chamber condition rather than the cartridges. When the two knobs are set to OPEN, the cartridges are both closed so no light can enter and it is safe to *open* the Film Chamber by removing it from the camera.

To shoot film, both knobs must be turned to CLOSE, but this must not be done until the Film Chamber is fully installed on the camera and the system thus *closed* to light. This actually opens the mouths of the film cartridges

Motor Drive MD, with separate Battery Case MD to power Servo EE Finder is also suitable for unattended photography.



Film Loader 250 spools bulk film into Film Magazine 250 for use in Film Chamber 250.

so film can pass freely from spool to spool. It also operates an electrical interlock switch which allows the motor drive to work.

Film is advanced by the sprocket in the F-1 camera in the normal way, except the camera itself may be driven by the MD or MF Motor Drive. To wind up the film onto the take-up spool in the Film Chamber, a small motor in the Film Chamber operates in synchronism with the film-advance motor in the motor-drive unit. When both work together, one frame of film is pulled across the camera and an equal amount is wound up on the take-up spool. If you advance the film manually, using the lever on the camera body, you should turn the take-up spool by an external knob on the Film Chamber to take up the slack—otherwise the film may jam or be scratched.

It is possible to use the Film Chamber 250 without a motor drive if, for example, you have a lot of copying to do. You must remember to wind up slack on the take-up spool manually each time you advance one frame.

HIGH-SPEED MOTOR-DRIVE CAMERA

A specially-modified F-1 camera with permanently-attached motor drive is available on special order. It can expose 4 to 9 frames per second but cannot use the Film Chamber 250. To achieve the higher speed, time lost in moving the mirror up and down is eliminated by using a special partially-reflecting mirror called a *pellicle*, which is permanently fixed in place. Some of the light passes straight through the special mirror to expose the film, and some is reflected up into the viewfinder. Thus your view of the scene is never interrupted by mirror "blackout."

It uses FD or FL lenses, both with manual aperture control with the Stopped-Down Lever on the camera locked in the stopped-down position. No provision is made for single-shot exposures except a quick trigger finger on the shutter button.

IMPROVEMENTS TO THE F-1—The improved F-1 camera was announced in late 1976, sometimes identified as the F-1N (new). Some of the improvements are discussed in the text, but not all are shown in the illustrations. The improvements are:

Adoption of the biprism/microprism focusing aid as standard.

Change in film-advance lever operation so the stand-off position is 30° from the camera back instead of 15°, and the throw is reduced to 139° instead of 180°. This makes the lever easier and faster to operate. Also, the end of the lever has a larger, redesigned thumb grip.

The mirror has been changed to reflect more blue light with an improvement in image brightness on the viewing screen.

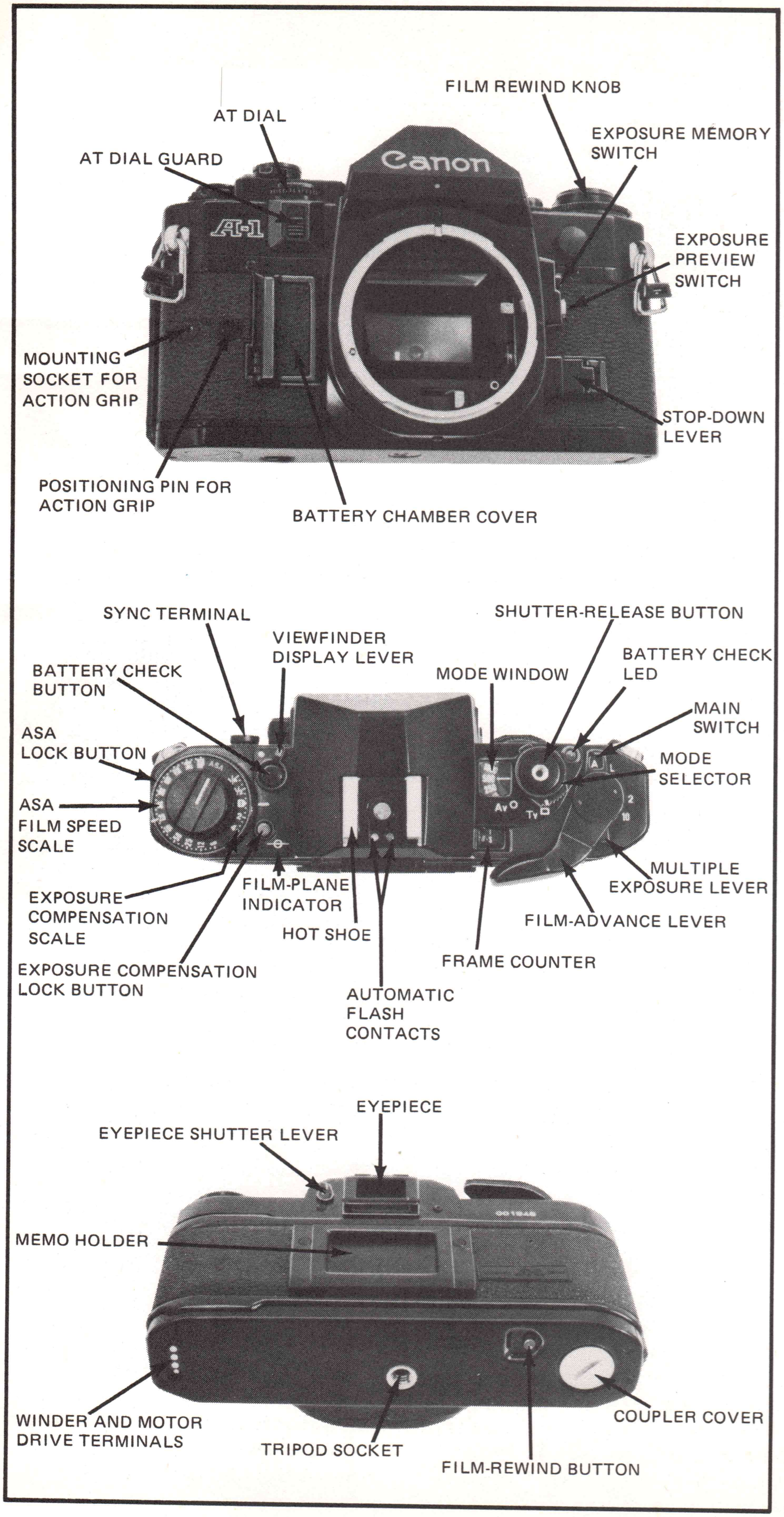
Multiple-exposure has been simplified and can be done on the improved model merely by depressing the rewind button and operating the film-advance lever.

Battery test button is now spring-loaded to return automatically to the off position. Film-rewind knob has a detent to hold it out while changing film.

The flash socket on camera body has been changed from a push-in type to a screw-in type of contact. The socket will still accept the old-style push-in type. The viewfinder window is now surrounded with a soft rubber ring to avoid scratching eyeglasses. The shutter button cup has been redesigned for greater operating comfort.

The camera back has been modified to add a memo holder to hold and display a film-box end as a reminder of the film type you have loaded in the camera.

ASA upper limit is 3200 instead of 2000.


FILM REWIND KNOB
AT DIAL
EXPOSURE MEMORY SWITCH
AT DIAL GUARD
EXPOSURE PREVIEW SWITCH
MOUNTING SOCKET FOR ACTION GRIP
STOP-DOWN LEVER
POSITIONING PIN FOR ACTION GRIP
BATTERY CHAMBER COVER
SYNC TERMINAL
SHUTTER-RELEASE BUTTON
VIEWFINDER DISPLAY LEVER
BATTERY CHECK BUTTON
MODE WINDOW
BATTERY CHECK LED
MAIN SWITCH
ASA LOCK BUTTON
MODE SELECTOR
ASA FILM SPEED SCALE
MULTIPLE EXPOSURE LEVER
EXPOSURE COMPENSATION SCALE
FILM-PLANE INDICATOR
FILM-ADVANCE LEVER
HOT SHOE
FRAME COUNTER
EXPOSURE COMPENSATION LOCK BUTTON
AUTOMATIC FLASH CONTACTS
EYEPIECE
EYEPIECE SHUTTER LEVER
MEMO HOLDER
WINDER AND MOTOR DRIVE TERMINALS
COUPLER COVER
TRIPOD SOCKET
FILM-REWIND BUTTON

THE A-1 CAMERA

The A-1 is both the simplest and the most complex 35mm SLR available today. This compact camera can be set to operate six different ways with FD lenses—five of them with automatic exposure!

It's the simplest because one of the automatic modes, called Programmed Automatic Exposure (AE) sets both shutter speed and aperture size for you automatically. All you have to do is focus. Set the lens at its hyperfocal distance and you eliminate the necessity of focusing, except for subjects very close to the camera. Add a motor drive or power winder and it advances film automatically. There's nothing left to do except operate the shutter button. No camera can be simpler than that!

It's also the most complex because of all the different ways it can operate and the variety of control settings you make to select the mode of operation. The A-1 is an amazing leap forward in camera technology with a very sophisticated digital computer built into the camera.

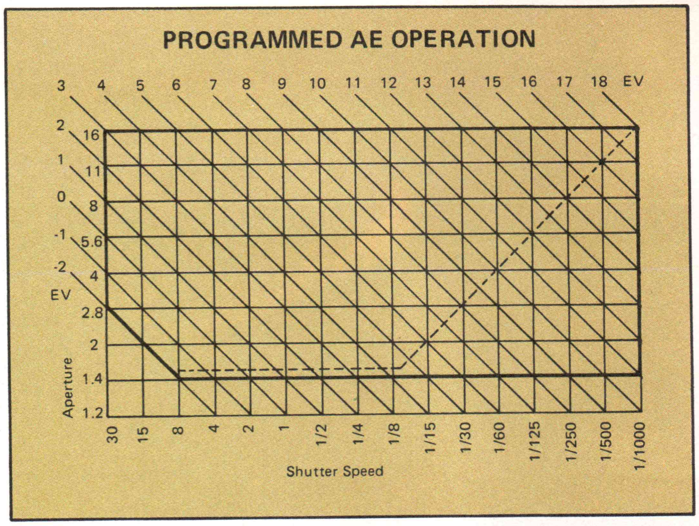
CHOOSING A MODE

The six modes of operation are briefly described here along with the reasons for choosing among them.

Aperture-Priority AE—You set aperture; the camera chooses shutter speed for correct exposure of an average scene. Use this mode when depth of field is important. If you choose small aperture to get lots of depth of field, the camera may use a very slow shutter speed which makes hand-holding difficult or impossible.

Shutter-Priority AE—You set shutter speed; the camera chooses aperture size for correct exposure of an average scene. Use this mode with moving subjects—either to stop motion or to produce a controlled amount of blur by choosing a slow shutter speed. If you choose a very fast shutter speed to stop motion, remember that the camera

Nothing intrudes into the image area of the A-1 so you can concentrate entirely on picture composition. All data is in the digital readout below the image.



When set for Programmed AE, the A-1 makes shutter-speed and aperture changes by following the dotted line on this graph.

may choose a large lens opening and you'll get very little depth of field.

Programmed AE—The camera sets both shutter speed and aperture size as described in Chapter 8, following a program that is built into the camera's computer. The program is shown in the accompanying illustration.

Use this mode when you don't have a specific shutter speed or aperture in mind, or when you don't want to bother with exposure settings. You can let the camera do it while you concentrate on composition of the photo. If you allow an inexperienced person to use your A-1, set it for Programmed AE and good exposures should result.

Electronic Flash AE—Using the special Canon 155A or 199A electronic flash, the camera is automatically set to the correct shutter speed and aperture size when the flash ready-light goes on. This gives very simple and nearly foolproof flash photography. All you have to do is consult the calculator dial on the back of the flash unit and stay within the automatic operating-distance range.

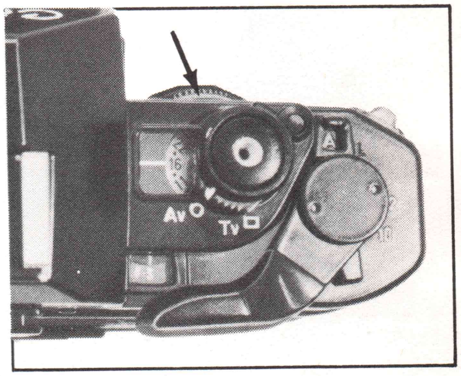
Stopped-Down AE—When using non-meter-coupled accessories between lens and camera, or an FL lens, or an FD lens not set to A, you control lens aperture manually. You can still operate with automatic exposure. The camera will set shutter speed to give correct exposure of an average scene.

Manual Override—Exposure control is *not* automatic. You set shutter speed *and* lens aperture manually. The camera exposure-measuring system continues to work but it doesn't set any controls. The camera display shows the shutter speed you have selected and the aperture size the camera exposure meter *recommends* for an average scene. You can set aperture to the recommended value, or not, as you choose. You may prefer this mode when you want to use an exposure different than the camera meter suggests—perhaps because you are shooting a non-average scene or you wish to produce a special effect by over- or underexposing.

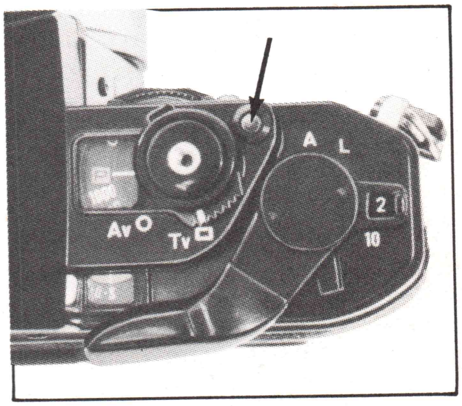
Special Controls—Choosing the mode of operation is done by setting controls in a logical sequence as shown in Figure 18-1.

For any mode, the first step is to turn the Main Switch from L to A. In the L position, the shutter button is locked. In the A setting, the camera can be operated. The Main Switch also serves as the self-timer control, described later.

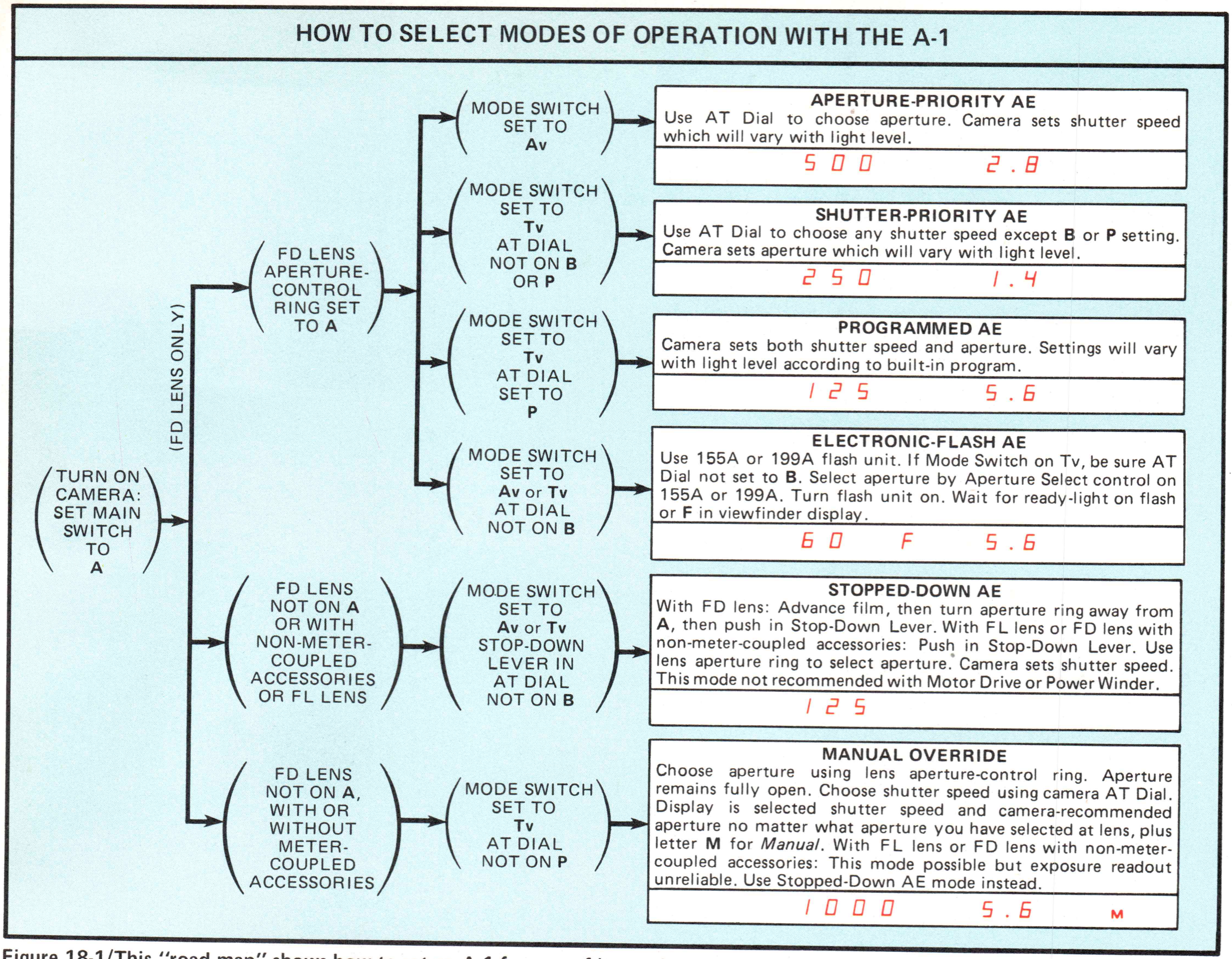
The next choice is automatic or non-automatic. The control is the



This A-1 is set for Aperture Priority (Av) and the AT Dial (arrow) is set at *f*-16. Main Switch is set to A so the camera is turned on and can be operated.



This A-1 is set for Programmed Shutter AE as you can see in the Mode Window. Main Switch is being used as self-timer control. Timer is set for 2 seconds. Battery Check LED (arrow) will flash as self-timer counts down.


HOW TO SELECT MODES OF OPERATION WITH THE A-1
TURN ON CAMERA: SET MAIN SWITCH TO A
(FD LENS ONLY)
FD LENS APERTURE-CONTROL RING SET TO A
MODE SWITCH SET TO Av
MODE SWITCH SET TO Tv AT DIAL NOT ON B OR P
MODE SWITCH SET TO Tv AT DIAL SET TO P
MODE SWITCH SET TO Av or Tv AT DIAL NOT ON B
FD LENS NOT ON A OR WITH NON-METER-COUPLED ACCESSORIES OR FL LENS
MODE SWITCH SET TO Av or Tv STOP-DOWN LEVER IN AT DIAL NOT ON B
FD LENS NOT ON A, WITH OR WITHOUT METER-COUPLED ACCESSORIES
MODE SWITCH SET TO Tv AT DIAL NOT ON P
APERTURE-PRIORITY AE
500 2.8
SHUTTER-PRIORITY AE
250 1.4
PROGRAMMED AE
125 5.6
ELECTRONIC-FLASH AE
60 F 5.6
STOPPED-DOWN AE
125
MANUAL OVERRIDE
1000 5.6 M

APERTURE-PRIORITY AE
Use AT Dial to choose aperture. Camera sets shutter speed which will vary with light level.

SHUTTER-PRIORITY AE
Use AT Dial to choose any shutter speed except **B** or **P** setting. Camera sets aperture which will vary with light level.

PROGRAMMED AE
Camera sets both shutter speed and aperture. Settings will vary with light level according to built-in program.

ELECTRONIC-FLASH AE
Use 155A or 199A flash unit. If Mode Switch on Tv, be sure AT Dial not set to **B**. Select aperture by Aperture Select control on 155A or 199A. Turn flash unit on. Wait for ready-light on flash or **F** in viewfinder display.

STOPPED-DOWN AE
With FD lens: Advance film, then turn aperture ring away from **A**, then push in Stop-Down Lever. With FL lens or FD lens with non-meter-coupled accessories: Push in Stop-Down Lever. Use lens aperture ring to select aperture. Camera sets shutter speed. This mode not recommended with Motor Drive or Power Winder.

MANUAL OVERRIDE
Choose aperture using lens aperture-control ring. Aperture remains fully open. Choose shutter speed using camera AT Dial. Display is selected shutter speed and camera-recommended aperture no matter what aperture you have selected at lens, plus letter **M** for *Manual*. With FL lens or FD lens with non-meter-coupled accessories: This mode possible but exposure readout unreliable. Use Stopped-Down AE mode instead.

Figure 18-1/This "road map" shows how to set an A-1 for any of its modes.

aperture ring on an FD lens. Set the ring to the green A or O and the camera is on automatic. Turn the ring away from A, to any *f*-number setting, and the camera is not on automatic. Only an FD lens that is mounted directly on the camera, or with meter-coupled accessories between lens and camera, can be set for automatic operation.

Then you choose one of two settings of the Mode Switch. As you remember from Chapter 8, Exposure Value (EV) is the combination of Aperture value (Av) and Time value (Tv). The Mode Switch has two settings: Av and Tv. If you select Av, you control aperture. If the camera is set for automatic, the camera will set shutter speed for correct exposure of an average scene.

If you select Tv with the camera on automatic, you set shutter speed and the camera sets aperture size automatically—with one exception discussed later.

After setting the Mode Switch, operate the AT Dial with your right forefinger. In every *automatic* mode of operation, you use the AT dial to do your part of setting exposure. The *same control* sets aperture size or shutter speed, depending on where you have set the Mode Switch. When you move the Mode Switch, a mask moves to the left or right in the Mode Window. If you select Av, the mask moves to show you a scale of aperture numbers. Use the AT Dial to select aperture. If you select Tv, the mask moves the other way to show a scale of shutter speeds. Use the AT Dial to select a shutter speed.

The exception mentioned earlier is Programmed AE. The setting for this mode is the symbol P which is on the shutter-speed scale, just past 1000. When you have the Mode Selector set to Tv, use the AT Dial to select shutter speeds *or* P if you want Programmed AE.

In all modes of operation, except one, the camera Stop-Down Lever is left in its normal position, not pushed in. To set up for Stopped-Down AE, the last step is to push in the Stopped-Down Lever.

More information about setting camera controls is in Figure 18-1.

AT Dial Guard—To prevent accidentally changing the setting of the AT Dial, slide the AT Dial Guard upward. The guard covers the AT Dial completely so it can't be changed.

Display—The viewfinder display is just below the viewfinder image area. This *digital readout* is "computer" characters formed by glowing red LEDs. The brightness of the readout is automatically changed as scene brightness changes, so the readout is neither too bright nor too dim in respect to the scene being viewed. There are four levels of display brightness.

Camera control of shutter speed and aperture is "stepless," meaning that any value can be chosen automatically whether or not the value is a marked shutter-speed number or *f*-number.

To avoid confusing the operator, the readout shows aperture and shutter speed to the nearest half-step and it changes the reading at half-second intervals or slower to give you time to read the display. If the scene illumination is changing rapidly, the viewfinder display may be both approximate and slightly behind in reporting settings to you. However, the camera itself responds instantly to changed light values.

Most of us are not accustomed to seeing numbers that represent half-steps in shutter speed and aperture. For example, 180 is halfway between 125 and 250 on the shutter-speed scale, and *f*-19 is a half-step larger aperture than *f*-22. Some of these intermediate numbers are approximations but this does not affect the exposure accuracy of the camera.

The digital language of the A-1 camera is shown in Figure 18-2, along with the two scales set by the AT Dial.

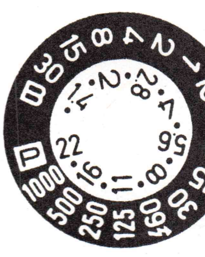
Warning Signals—In general, the camera will cause part or all of the digital readout to blink on and off to warn you that something is wrong. There are exceptions.

THE A-1 DIGITAL LANGUAGE

VIEWFINDER SHUTTER-SPEED READOUT	
Shutter speeds in fractions of a second from 1/1000 to 1/2. Includes full steps such as 1/1000, 1/500, 1/250 and half steps such as 1/750, 1/350, 1/180.	1000 750 500 350 250 180 125 90 60 45 30 20 15 10 8 6 4 3 2
Shutter Speeds in whole seconds or decimals. " means second. 0"7 = 0.7 second 1" = 1 second 1"5 = 1.5 second Includes full and half steps.	0"7 1" 1"5 2" 3" 4" 6" 8" 10" 15" 20" 30"
Shutter speed set to B.	buLb

VIEWFINDER APERTURE READOUT	
32 27 22 19 16 13 11 9.5 8.0 6.7 5.6 4.5 4.0 3.5 2.8 2.5 2.0 1.8 1.4 1.2	Aperture settings from *f*-32 to *f*-1.2 in full steps such as *f*-32, *f*-22, *f*-16 and half steps such as *f*-27, *f*-19, *f*-13.

CAMERA AT DIAL SETTINGS



Outer scale visible on Tv. P selects programmed AE. Inner scale visible on Av. Dots are half steps.

VIEWFINDER SPECIAL SYMBOLS

F	bu F	EEEE EE	M
Speedlite 155A or 199A installed and ready to flash.	Speedlite 155A or 199A installed and ready, shutter on **B**.	Operator error made in switching back to automatic after viewing depth of field.	You must control aperture or shutter manually.

Figure 18-2/The A-1 uses these symbols in the digital readout.

Because the A-1 has six ways to operate, there is an assortment of things you can do wrong. The warning signals and what to do about them are in Figure 18-3. Even though it may appear complicated, the warning-system logic is fairly simple and obvious once you become acquainted with it.

For example, if you are choosing aperture and the camera is choosing shutter speed, the camera will display a flashing shutter-speed readout if it cannot find a speed that gives correct exposure. If you are setting shutter speed, the camera will flash the aperture readout to show incorrect exposure. If the camera is setting *both* controls, on Programmed AE, it will flash both readouts to show incorrect exposure.

Camera On-Off Control—The Main Switch, turns the camera on and unlocks the shutter button when set to A. Then the viewfinder display is turned on by depressing the shutter button partway—until you feel resistance—or by depressing the Exposure Preview Switch or by depressing the Exposure Memory Switch.

Metering—Canon's central emphasis metering pattern is used with a silicon sensor. Metering range is EV -2 to EV 18 at ASA 100 with an *f*-1.4 lens.

Self-Timer—Rotating the Main Switch to 2 or 10 prepares the camera for self-timing with a delay of 2 to 10 seconds, respectively. To begin the self-timer cycle, depress the shutter button. If set for 10 seconds,

A-1 PRECAUTIONS AND WARNING SIGNALS

PROBLEM	WARNING, RESULT & CORRECTION
APERTURE-PRIORITY AE	
You choose an aperture on the AT Dial that is larger than the maximum aperture of the lens.	No warning. Lens opens as much as it can. Camera chooses shutter speed for actual lens opening. Exposure is OK. Display shows max. aperture of the lens, rather than aperture on AT Dial.
You choose an aperture on the AT Dial that is smaller than the minimum aperture of the lens.	No warning. Lens closes as much as it can. Camera chooses shutter speed for aperture on AT Dial, rather than actual shooting aperture. Photo is overexposed. Display shows aperture on AT dial.
Overexposure	1000 5.6 Camera chooses fastest shutter speed and flashes shutter-speed readout. Change to smaller aperture setting.
Underexposure	30'' 5.6 Camera chooses slow shutter speed and flashes shutter-speed readout. Change to larger aperture setting.
Light too dim for AE photography—below meter-coupling range.	30'' 1.4 Both shutter-speed and aperture readouts flash. Change to lens with larger maximum aperture; change to film with higher speed; put more light on scene.
Light too bright for AE photography—above meter-coupling range.	1000 16 Shutter-speed readout flashes even at smallest aperture setting. Change to lens with smaller minimum aperture; change to film with lower speed; use ND filter; put less light on scene.
STOPPED-DOWN AE	
Camera Stop-Down lever locked in before FD or FL lens mounted on camera or on bellows or extension tubes that preserve automatic aperture such as Bellows FL, Extension Tubes FL, Extension Tubes FD 25 and 50.	No warning. Exposure will be incorrect. Avoid problem by always checking camera body before mounting lens. If you see red dot beside camera Stop-Down Coupling Lever, camera Stop-Down Lever is locked in. Release Stop-Down lever before mounting lens.
When switching from any other AE mode to Stopped-Down AE, lens aperture ring is turned away from A before film is advanced for next shot.	No warning. Preview metering and viewing depth of field may be done at wrong aperture because lens will not stop down smaller than shooting aperture for last exposure until film is advanced. This will not cause incorrect exposure because you must advance film before exposing next frame. When you shoot next frame, metering is done again, automatically, and exposure will be OK.
Intending to switch back to AE, you return lens aperture-control ring to A but forget to unlock camera Stop-Down Lever.	Warnings: Viewing screen is dark; display is shutter speed only. Camera will set exposure automatically but lens will remain at minimum aperture. Exposure will be correct if there is enough light. If not, shutter-speed display will flash. This is not recommended and severely strains camera mechanism.

PROBLEM	WARNING, RESULT & CORRECTION
SHUTTER-PRIORITY AE	
Possible overexposure	125 22 An *f*-number from *f*-19 to *f*-32 will flash. This aperture is camera-recommended value for correct exposure. By flashing display, camera is "asking" you if the lens will stop down that much. If it will, exposure is OK. If minimum aperture of lens is larger than flashing aperture, overexposure is indicated. Correct by changing to faster shutter speed until flashing aperture agrees with minimum aperture of lens. If lens minimum aperture is *f*-32: Because *f*-32 is smallest aperture that can be displayed, a flashing *f*-32 is ambiguous because camera may have wanted *f*-64 or *f*-128. Test by switching to faster shutter speeds until flashing aperture readout changes to *f*-22. That setting will give correct exposure. Also one step slower shutter speed, with flashing *f*-32, will give correct exposure. If lens minimum aperture is *f*-16: Occasionally, *f*-16 may flash. Switch to faster shutter speeds until flashing aperture changes to *f*-11. Exposure will be OK at that shutter speed or one step slower, with *f*-16 flashing.
Underexposure	500 1.4 Camera chooses large aperture and flashes aperture readout. Switch to a slower shutter speed until display stops flashing.
Light too dim for AE photography—below meter-coupling range.	30'' 2.8 Both shutter-speed and aperture readouts flash. Change to film with higher speed; increase light on scene; change to lens with larger maximum aperture.
Light too bright for AE photography—above meter-coupling range.	1000 32 Aperture readout flashes even at fastest shutter-speed setting. Correction may be: Change to film with lower speed; decrease light on scene; use ND filter; change to lens with smaller minimum aperture.
ELECTRONIC-FLASH AE (With FD lens and Speedlite 155A or 199A)	
You set Aperture Selector on flash to call for aperture larger than maximum aperture of lens on camera.	60 F 2.8 Display flashes maximum aperture of lens in use to indicate underexposure. Change Aperture Selector on flash to call for aperture lens can use.
You set Aperture Selector on flash to call for aperture smaller than *f*-16. Overexposure is possible if lens won't close down that far.	60 F 22 Aperture requested by Aperture Selector on 155A or 199A will appear in display and numerals will flash on and off. If lens minimum aperture is equal to or smaller than flashing value, exposure will be OK. If lens minimum aperture is larger than flashing value, overexposure will result. Set Aperture Selector on flash unit to an aperture size that can be set on lens.

A-1 PRECAUTIONS AND WARNING SIGNALS

PROBLEM	WARNING, RESULT & CORRECTION
	MANUAL OVERRIDE
(Camera display serves as exposure guide. If you set aperture as shown in display, these warnings and signals will apply.)	
Possible overexposure	125 22 An aperture display trom *f*-19 to *f*-32 will flash. If you set lens at that aperture, exposure will be OK. If lens minimum aperture is *f*-32 or *f*-16 and camera displays flashing *f*-32 or *f*-16, apply same tests described in Shutter-Priority section.
Underexposure	500 1.4 Camera displays large aperture and flashes readout.
Light level below meter-coupling range.	30'' 2.8 Both shutter-speed and aperture readouts flash.
Light level above meter range.	1000 32 Aperture readout flashes even at fastest shutter-speed setting.

PROBLEM	WARNING, RESULT & CORRECTION
	PROGRAMMED AE
Overexposure or light too bright for AE photography.	1000 16 Display flashes both fast shutter speed and small aperture.
Underexposure or light too dim for AE photography.	30 4 Display flashes both slow shutter speed and large aperture.
	MISCELLANEOUS
To view depth of field, you take the lens off A and push in the Stop-Down Lever. Then you unlock the Stop-Down Lever and return the lens to A.	EEEE EE Shutter button and Film-Advance Lever are both inoperative. Depressing shutter button partway causes display to show error signal even if display is turned off. Operate Multiple Exposure Lever and Film-Advance Lever so AE operation becomes possible again.

Figure 18-3/If you set the controls wrong in any of the A-1 modes, the digital readout usually flashes a warning signal.

the adjacent Battery Check LED signal light will flash at two per second for the first eight seconds. During the final two seconds of delay, the LED flashes eight times per second. If you select a delay of 2 seconds, the flash rate is eight per second for the entire period.

Be sure film is advanced and the camera is ready to make the next exposure before starting the self-timer. If film is not advanced, the self-timer will not function. Advance the film and it will work OK.

If the self-timer cycle is in progress and you decide not to make the exposure, you can cancel two ways: Move the Main Switch to L or depress the Battery Check Button.

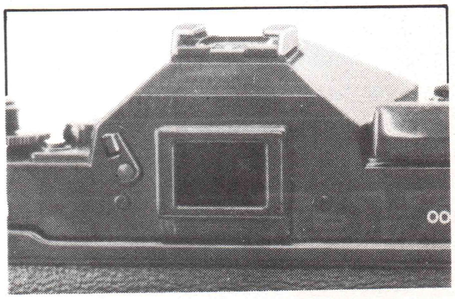
When using Power Winder A or Motor Drive MA, you can use the self-timer as an intervalometer. Set the self-timer, then hold down the shutter button with a locking cable release. If you select a delay or 2 seconds, the camera will make an exposure every 2 seconds until it runs out of film. If you choose 10 seconds, the camera makes an exposure every 10 seconds. Power Winder A must be turned on; Motor Drive MA must be turned on and set to either of its continuous-operation speeds, H or L.

Eyepiece Shutter Lever—If the A-1 is on automatic and your eye is not at the eyepiece, use the Eyepiece Shutter lever to close an internal blind. This prevents light from entering the camera through the eyepiece and causing incorrect exposure.

Multiple Exposures—After the first exposure, close the film-advance lever fully against the camera body. This uncovers the Multiple Exposure Lever. Push the Multiple Exposure Lever fully to the left so it disappears beneath the film-advance lever and uncovers a red dot on the camera top. Move the film-advance lever through one full stroke as if you were advancing film.

This does not advance film. It "winds up" the camera so it can make another exposure on the same frame. Repeat for as many multiple exposures as desired. The frame counter does not advance during multiple exposures so the frame count remains accurate.

Multiple exposures are not possible when using a motor drive or power winder. If you operate the Multiple Exposure Lever, the motor drive or power winder is automatically turned off so it will not advance film.

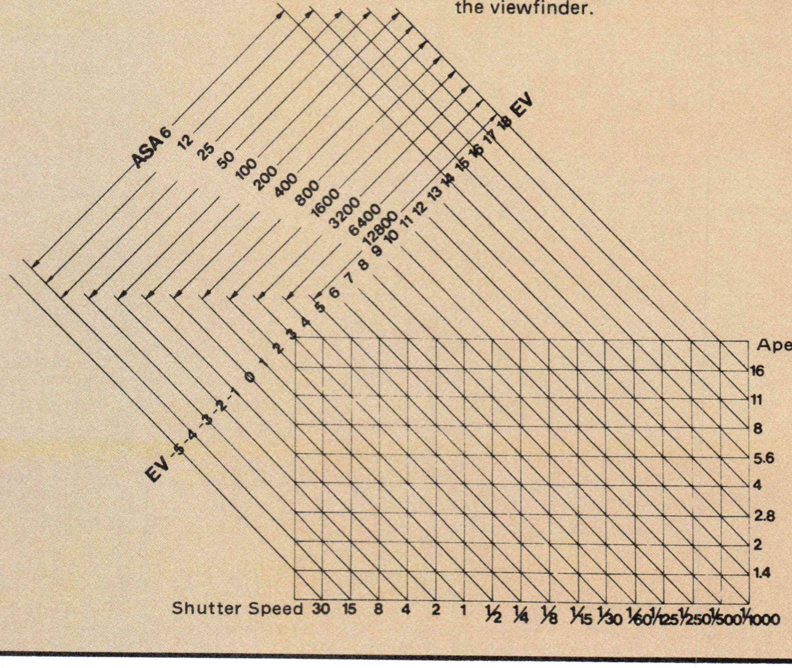


When using any of the A-1 automatic modes of operation, if your eye is not at the viewfinder, close the eyepiece shutter to prevent incorrect exposure due to light entering the viewfinder eyepiece. Eyepiece Shutter Lever is on left side of eyepiece.

A-1 METER COUPLING AND AUTOMATIC EXPOSURE RANGE

Meter Coupling Range
When using the FD 50mm f-1.4 S.S.C. lens and ASA 100 film, the built-in exposure meter couples within a range of EV -2 to EV 18.

AE Coupling Range
At indicated film speeds, the built-in exposure meter couples with the aperture and shutter speed as indicated. Outside the coupling range, the camera warns you by flashing data inside the viewfinder.



Viewing Depth of Field—This procedure is affected by the way camera and lens work together as described in Chapter 10.

For any AE mode except Stopped-Down AE: The simplest way is to view depth of field before advancing film. Turn on the meter; notice the aperture size indicated in the display. Take the lens off A and set to the indicated aperture size. Depress the Depth-of-Field Lever on the camera body. The viewfinder image will darken if you have selected an aperture smaller than wide open and you will see depth of field at that aperture. Release the Depth of Field Lever so it moves back out. Return the lens to A. Advance film. Make the next exposure.

If you decide to view depth of field *after* you have advanced film, the procedure is as described plus one more step. After you return the lens to A, the shutter button and film-advance lever are both locked. When you turn on the meter, the display reads EEEE EE. Move the film-advance lever fully against the camera body. Push the Multiple Exposure Lever to the left. Then move the film-advance lever through one full stroke. This does not advance the film but it resets the lens and camera mechanism to operate automatically once again. Use the camera normally for the next exposure.

For Stopped-Down AE—You see depth of field constantly because lens aperture is controlled manually and takes the value you set on the aperture ring.

For Manual Override—If you push in the Depth-of-Field Lever, the camera mode is switched to Stopped-Down AE and you see depth of field at whatever aperture you have selected. You can make the exposure with the lens stopped down if you wish. If you prefer to return to Manual Override before making the exposure, just release the Stop-Down Lever so it moves out to its normal position.

Stopped-Down Metering—There is no need to meter stopped-down with an FD lens mounted directly on the camera or through meter-coupled accessories. It is *possible* in the Stopped-Down AE mode by moving the lens aperture ring away from A. With an FD lens set to A, the camera Stop-Down Lever is blocked so you can't push it in.

When an FD lens is used with non-meter-coupled accessories between lens and camera, or when an FL lens is being used, you can perform stopped-down metering simply by pushing in the Stop-Down Lever. This puts the camera in the Stopped-Down AE mode as you can see by reference to Figure 18-1.

To restore normal full-aperture metering with an FD lens, release the Stop-Down Lever.

Memory Hold— Point the camera at the surface on which you want to set exposure. Depress and hold in the Exposure Memory Switch while pointing the camera wherever you wish and making the exposure. Then release the memory switch.

In any of the AE modes, this control actually holds the Exposure Value rather than locking shutter speed only or aperture only. While holding in the Exposure Memory Switch, you can change either aperture or shutter speed and the camera will automatically make a compensating adjustment of the other control so exposure remains the same.

Mirror Lockup—There is no way to lock up the mirror, however the camera mechanism is designed to minimize vibrations caused by mirror motion.

Very Long Exposures—The camera will time exposures as long as 30 seconds. If you need longer exposures, use a locking cable release with the Main Switch set to A.

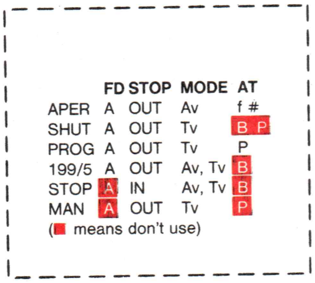
Film Speed—To turn the ASA Film Speed Scale, depress the ASA Lock Button with your fingernail.

Exposure Compensation—With the camera in any AE mode, the best way to get more or less exposure than the camera would give automatically is to use the Exposure Compensation Scale. Exposure compensation is indicated by numbers which are factors or multipliers:

Exposure Compensation Setting	Exposure Steps
1/4	−2
1/2	−1
1	0
2	+1
4	+2

The control cannot be moved until you depress the adjacent Exposure Compensation Lock Button. In effect, this control changes the film-speed setting. When you don't want exposure compensation, return the control to 1. It's important to remember to do this because there is no signal in the viewfinder.

Because the intermediate steps on the film-speed scale are 1/3 steps, the subdivisions on the exposure-compensation scale are also 1/3 steps. The effect of changing the exposure-compensation setting appears in the viewfinder display by a changed readout. Because the readout only shows half-steps and exposure compensation can be made in 1/3 steps, the viewfinder readout may be approximate. Actual compensation will agree with your setting on the Exposure Compensation Scale.



	FD	STOP	MODE	AT
APER	A	OUT	Av	f #
SHUT	A	OUT	Tv	B P
PROG	A	OUT	Tv	P
199/5	A	OUT	Av, Tv	B
STOP	A	IN	Av, Tv	B
MAN	A	OUT	Tv	P

(🟥 means don't use)

This "shorthand" table shows how to set the A-1 for the six modes of operation shown at left. Controls are listed across the top: FD means lens; STOP means Stop-Down Lever; MODE means Mode Switch; AT means AT Dial. Settings are in body of table. Red overlay means don't use that setting. You can copy this on a copier, cut along the dotted line and it will fit in the Memo Holder on the camera back cover.

The limits of the film-speed range also apply to the exposure-compensation control. If you have film speed set to ASA 6, you can't get two steps more exposure by using the exposure-compensation control. You can get two steps less exposure because that is the same as setting to ASA 25.

ASA FILM SPEED	USABLE RANGE OF EXPOSURE COMPENSATION
6	1/4, 1/2, 1
12	1/4, 1/2, 1, 2
25 to 3200	1/4, 1/2, 1, 2, 4
6400	1/2, 1, 2, 4
12800	1, 2, 4

Obviously you can do the same thing by changing the film-speed setting of the camera but there's no good reason to do that unless you need more than two steps of exposure compensation—for example if you are making eight overlapping multiple exposures on the same frame you would need 1/8 or 3 steps less exposure for each shot.

When set to Manual Override you get exposure compensation by setting the controls anywhere you choose, using the viewfinder exposure display as a guide.

When using Aperture-Priority AE, you can take an FD lens off the A setting to make an exposure compensation. The viewfinder readout will show shutter-speed, camera-recommended aperture and the M symbol. Exposure will be made at the indicated shutter speed and the aperture you select on the lens.

Intermediate Control Settings—When on automatic, the camera can make intermediate settings of both shutter speed and aperture. When you are setting either of these controls manually: Intermediate settings on the lens aperture ring are OK; intermediate settings using the AT Dial are pointless because the camera will use one of the adjacent marked settings.

Display Switch—When operating on automatic, or with the 199A or 155A, or on Manual Override, you may not be interested in seeing the viewfinder readout. Switch it off by turning the Viewfinder Display Lever counterclockwise so it covers the white dot on the camera top. This prevents display except for the warning EEEE EE.

Battery Check—The Battery Check Button is in the center of the Viewfinder Display Lever. With the Main Switch set to A, depress the check button and the Battery Check LED will flash rapidly if the battery is OK. If the LED flashes slowly or not at all, replace the battery.

The Battery Check Button can also be used to cancel the self-timer and to close the shutter if, for example, you inadvertently open the shutter with the controls set for a very long exposure.

Conserving Battery Power—The A-1 is completely disabled if the battery is dead or missing. Camera batteries can fail suddenly and without warning. Always carry a spare. Then, if the one in the camera fails, you can replace it and resume shooting.

The camera uses battery power to operate the viewfinder readout and to hold the shutter open. You can make a small saving in battery power by not holding the readout turned on for long periods and a major saving by avoiding extremely long time exposures. When the camera is not in use, set the Main Switch to L. This turns off all electrical circuits.

Battery Compartment—The hot-shoe cover has a small projection which can be used to open the battery compartment cover. Push it into the slot at the lower left side of the cover.

Using Aperture Smaller Than *f*-22—When set for automatic, the smallest aperture you can select with the

AT Dial is *f*-22. Some Canon lenses have smaller apertures. If you need to use a smaller aperture than *f*-22, set the camera controls for Stopped-Down AE and control lens aperture manually, using the aperture ring on the lens.

Unusable Lenses—A few early lenses are incompatible with the A-1 and should not be installed on the camera. These are:

FL 19mm *f*-3.5
FL 58mm *f*-1.2
R 58mm *f*-1.2
R 100mm *f*-3.5

Frame Counter—Counts frames as they are exposed, up to 38. Does not advance during multiple exposures, so the count remains correct. Counts backwards during film rewind. If you stop rewinding at S, there will be about as much film leader extending from the cartridge as there was when you loaded it. No matter what the counter reads, it is automatically reset to S when you open the camera back cover.

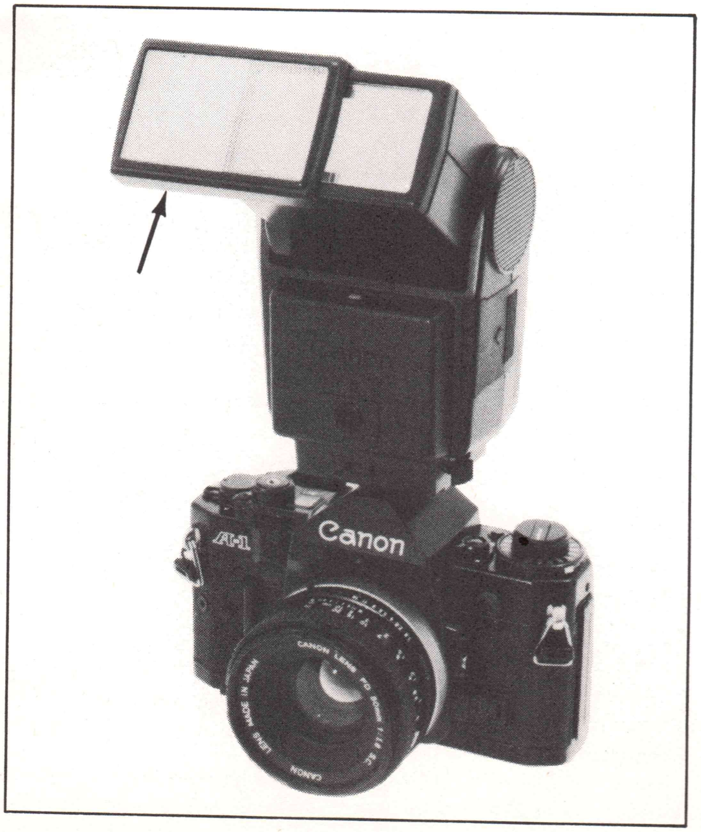
Using The Shutter Button—Good practice is to squeeze the shutter button gently rather than work it with a jerky motion. If you operate the button quickly, without pausing for the data readout in the viewfinder, the data may not be displayed at all and the camera may hesitate before releasing the shutter. Exposure will be the same as if you had operated the button slowly. If you depress the shutter button very rapidly, the shutter may not operate at all.

Once the shutter button is fully depressed and the camera cycle of operation has started, you don't need to hold the button in even for longer exposures. The exposure settings are memorized in the camera's digital computer at the instant of shutter-button operation and the camera will operate accordingly.

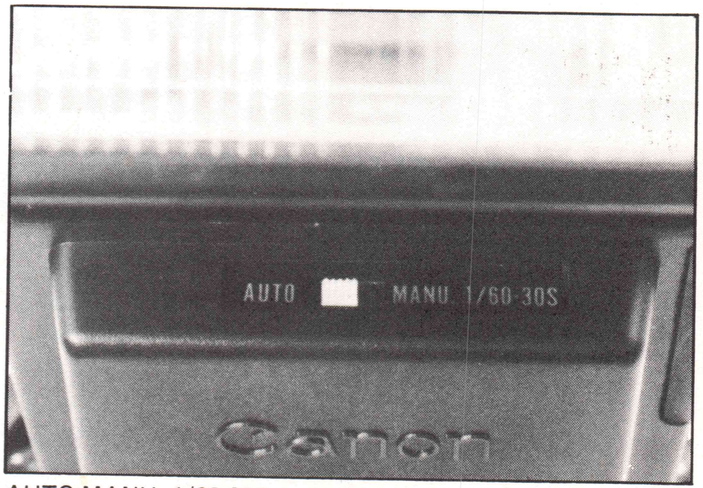
Flash—The A-1 can use flashbulbs, ordinary electronic flash, light-sensing automatic electronic flash, and the special 155A and 199A flash units designed for A-series cameras. See the accompanying flash sync table. It is possible to fire two flash units simultaneously—one in the hot shoe and one connected to the sync terminal—but not recommended.

Because of the variety of modes of operation, there are many different ways to use electronic flash. These are shown in Figure 18-4.

When using the 155A or 199A flash with the camera on automatic, the flash controls both lens aperture and shutter speed, but takes control only when the flash ready-light is on. Between flashes, while th unit is recharging, the camera reverts to normal automatic operation using whatever amount of light is on the scene. The viewfinder readout changes each time the flash is ready to fire, showing shutter speed, lens aperture and the symbol F. *However* the readout *will not* change and the flash ready-light *will not* come on while you are depressing any of the buttons that turn on the viewfinder display.



Canon Speedlite 199A has bounce flash capability. Flash head tips upward but flash sensor on front of case remains pointed straight ahead. Flash comes with Wide Adapter (arrow) which increases beam angle from coverage of 35mm lens to coverage of 24mm lens.



AUTO-MANU. 1/60-30S control on 199A is on front of case but concealed until you tip up the flash head.

FLASH PHOTOGRAPHY WITH THE A-1

Flash Type	Method of Operation	Flash Control Settings	A-1 Control Settings	Display
199A 155A	ELECTRONIC FLASH AE Flash sets camera to 1/60 and aperture called for by Aperture Selector on flash. Exposure controlled by light sensor in flash.	199A: Aperture Selector to red, green or yellow. AUTO-MANU. 1/60–30s to AUTO. 155A: Aperture selector to red or green.	FD lens to A. Mode Switch to AV or Tv. AT Dial not on B.	60 F 5.6 F indicates flash ready. Aperture readout flashes to indicate incorrect settings. See Figure 18-3.
199A	ELECTRONIC FLASH AE Camera automatically set to 1/60 when AT Dial set to 1/60 or faster; slower shutter speed when AT Dial set from 1/30 to 30 sec. but not B. Camera aperture set automatically to value called for by Aperture Selector on flash. Flash exposure controlled by light sensor in flash. Ambient-light exposure controlled by shutter speed selection.	199A: Aperture Selector to red, green or yellow. AUTO-MANU. 1/60–30s switch to MANU.	FD lens to A. Mode Switch to Tv. AT Dial not on B.	2'' F 5.6 F indicates flash ready. Aperture readout flashes to indicate incorrect settings. See Figure 18-3.
199A 155A	AUTOMATIC FLASH with manual aperture control. Camera automatically set to 1/60. 1/60 to 30 sec. exposure possible with 199A. You set lens aperture manually to agree with aperture called for by setting of Aperture Selector on flash—same as aperture shown in display. Flash exposure controlled by light sensor in flash. Use FL lens, FD lens not on A or FD lens with non-meter-coupled accessories.	199A: Aperture Selector to red, green or yellow. AUTO-MANU. 1/60–30s switch to AUTO for 1/60, to MANU. for 1/60 to 30s. 155A: Aperture Selector to red or green. No choice of shutter speed—it will be set to 1/60.	FD lens not on A, or FD lens with non-meter-coupled accessories or FL lens. Mode Switch to Tv. AT Dial below 1/60 for longer ambient-light exposure with 199A. AT Dial not on B.	60 F 2.8 M F indicates flash ready. M indicates lens aperture must be set manually. With FD lens, warnings same as Electronic Flash AE. See Figure 18-3. With FL lens or FD lens with non-meter-coupled accessories, underexposure warning is not reliable.
199A 155A	NON-AUTOMATIC FLASH with manual aperture control. Camera automatically set to 1/60. 1/60 to 30 sec. exposure possible with 199A. You control exposure by aperture setting. Use flash guide number calculation or flash calculator dial as reference.	199A: Aperture Selector to M. AUTO-MANU. 1/60—30s switch to AUTO for 1/60 to MANU. for 1/60 to 30s. 155A: Aperture Selector to MANU.	FD lens not on A, or FD lens with non-meter-coupled accessories or FL lens. Mode Switch to Tv. AT Dial below 1/60 for longer ambient-light exposure with 199A. AT Dial not on B.	60 F M F indicates flash ready. M indicates lens aperture must be set manually. No warning signals.
199A 155A	SHUTTER ON B, AE Flash automatically sets camera aperture to value called for by setting of Aperture Selector on flash—same as aperture shown in display. Flash exposure controlled by light sensor in flash. Ambient-light exposure determined by how long you hold shutter open.	199A: Aperture Selector to red, green or yellow. AUTO-MANU. 1/60–30s switch in either position. 155A: Aperture Selector to red or green.	FD lens to A. Mode Switch to Tv. AT Dial to B.	bu F 2.8 bu indicates B setting. F indicates flash ready. Aperture display flashes to indicate incorrect settings. Warnings same as Electronic Flash AE. See Figure 18-3.
199A 155A	SHUTTER ON B, AUTOMATIC FLASH with manual aperture control. You set lens aperture manually to agree with aperture called for by Aperture Selector on flash—same as aperture shown in display. Flash exposure controlled by light sensor in flash. Ambient-light exposure determined by how long you hold shutter open.	199A: Aperture Selector to red, green or yellow. AUTO-MANU. 1/60–30s switch in either position. 155A: Aperture Selector to red or green.	FD lens not on A, or FD lens with non-meter-coupled accessories or FL lens. Mode Switch to Tv. AT Dial to B.	bu F 2.8 M bu indicates B setting. F indicates flash ready. M indicates lens aperture must be set manually. With FD lens, warnings same as Electronic Flash AE. See Figure 18-3. With FL lens or FD lens with non-meter-coupled accessories, underexposure indication is unreliable.
199A 155A A-33 AB-46 AB-56	SHUTTER ON B, NON-AUTO FLASH Flash does not control exposure or make camera settings. Make flash guide-number calculation or use flash calculator dial for reference.	199A: Aperture Selector to M. AUTO-MANU. 1/60–30s switch in either position. 155A: Aperture Selector to MANU. A-33, AB-46, AB-56: set to Manual.	FD lens not on A, or FD lens with non-meter-coupled accessories or FL lens. Mode Switch to Tv. AT Dial to B.	bu F M bu indicates B setting. F indicates flash ready. M indicates lens aperture must be set manually. No warning signals.
A-33 AB-46 AB-56 other brands	ORDINARY FLASH PHOTOGRAPHY You make all camera settings. Flash controls exposure if light-sensing type. If non-light-sensing or set for manual operation, make guide-number calculation or use flash calculator dial for reference.	Auto or Manual as appropriate.	FD lens not on A, or FD lens with non-meter-coupled accessories or FL lens. Mode Switch to Tv. AT Dial to 1/60 or slower; not on B.	60 4.5 M M indicates lens aperture must be set manually. Aperture readout is appropriate *without* flash. Disregard or turn off display.

Figure 18-4/You can use electronic flash with every A-1 mode of operation. This table shows how.

A-1 FLASH SYNCHRONIZATION

TYPE	SHUTTER SPEED
199A	1/60 or slower
155A	1/60
A-33	1/60 or slower
AB-46	1/60 or slower
AB-56	1/60 or slower
133D (non auto)	1/60 or slower
Flashbulbs	1/30 or slower

If you want to watch the display to see the symbol F that indicates flash is ready to fire, the trick is to turn the display on and off while you are watching. During one of the off periods, the display will change and the flash ready-light will simultaneously turn on.

Focusing Screens—The standard screen uses a split-image surrounded by a microprism, surrounded by a matte field. The screen can not be changed by the user but can be changed to another type by Canon factory service centers. For a list of available screens, check with your Canon dealer or the nearest factory service center.

Major Accessories—The A-1 can use all Canon lenses and lens accessories and all viewfinder eyepiece accessories. Special accessories include Power Winder A, Motor Drive MA, Electronic Flash 155A and 199A and Data Back A.

A-1 SPECIFICATIONS

Type: 35mm SLR with 5 AE modes and one manual mode. Focal-plane shutter, quick-return mirror and standard Canon Breech-Lock lens mount.

Standard Lenses: Canon FD 55mm and 50mm lenses.

Interchangeable Lenses: Canon FD series usable in all modes, Canon FL series usable in Stopped-Down AE mode.

Viewfinder: Fixed eye-level pentaprism. Standard eyepiece is −1 diopter.

Viewfinder Information: LED digital readout shows shutter speed, aperture, manual indication, flash-ready signal, B setting, and warning signals.

Eyepiece Attachments: Angle Finders A2 and B, Magnifier S, ten Dioptric Adjustment Lenses S, Eyecup 4S. Built-In Eyepiece Shutter.

Focusing Screen: Split-image surrounded by microprism. Can be changed at Canon factory service centers.

Field of View: 93.4% vertical and 95.3% horizontal coverage of actual picture area.

Shutter: Cloth focal-plane, electronically controlled.

Self-Timer: Electronic, activated by shutter button. Can be set for delay of 2 or 10 seconds. LED indicator flashes during countdown with faster rate during last 2 seconds.

Film-Speed Range: ASA 6 to ASA 12800.

Exposure Meter: Silicon photocell with Central Emphasis metering pattern.

Meter Coupling Range: EV −2 to EV 18 at ASA 100 with 50mm *f*-1.4 lens.

Exposure Memory: Exposure Memory Switch locks in EV setting.

Exposure Compensation: Two steps increase or decrease in 1/3 step increments except at extremes of film-speed range.

Exposure Preview: Viewfinder readout turned on by depressing shutter button partway or by depressing Exposure Preview Switch or by depressing Exposure Memory Switch.

Battery: One 6V #544 or equiv.

Battery Check: LED indicator.

Multiple Exposures: Use Multiple Exposure Lever.

Flash Synchronization: X sync at 1/60; FP and M at 1/30 or slower.

Flash Connections: Hot shoe has conventional center contact plus two special contacts for Speedlite 199A or 155A. Standard sync terminal on camera body.

Film-Advance Lever: Single or multiple-stroke; 120° throw; 30° standoff.

Film-Rewind: Use rewind button and crank.

Frame Counter: Does not advance during multiple exposures. Counts backward during rewind. Resets to S automatically when back cover opened.

Dimensions: Body only: 141 x 91.5 x 47.5mm (5-9/16″ x 3-5/8″ x 1-7/8″).

Weight: Body only: 620g (1.34 lbs.).

Specifications subject to change without notice.

THE AE-1 CAMERA

The AE-1 is camera on the outside and computer on the inside. The result is a shutter-preferred automatic camera of reduced size and weight, with some unique operating features and accessories, and a relatively low cost.

The basic intent is to offer rapid-fire automatic photography with the camera doing as much of the job as possible. When used with Speedlite 155A or 199A and Power Winder A, the AE-1 camera succeeds in an impressive way. All you have to do is focus and press the shutter button. The camera sets exposure with and without the flash in use; the Power Winder advances film a frame at a time or at 2 frames-per-second if the shutter button is held down. Power Winder A and 199A or 155A can be used simultaneously. The camera and its accessories take care of all the details.

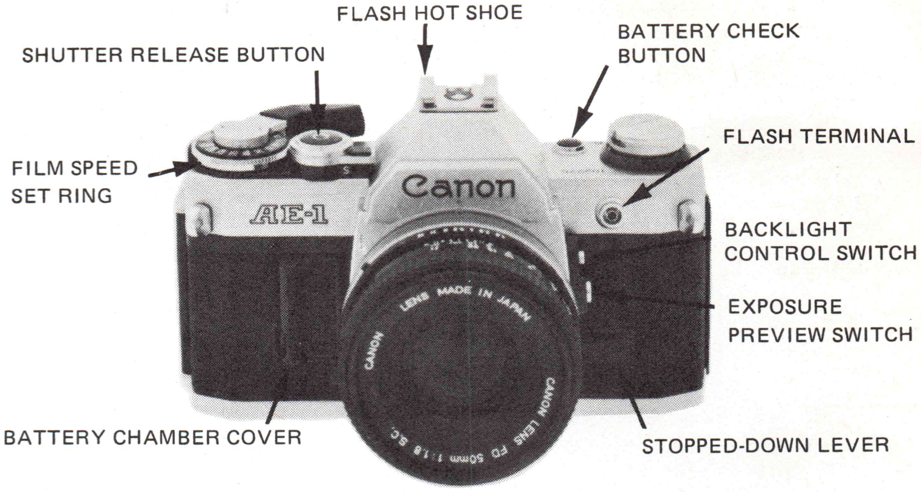
If you are deciding on a camera, compare its features to the other cameras in the line. Consider what the AE-1 will do, and also what it won't do.

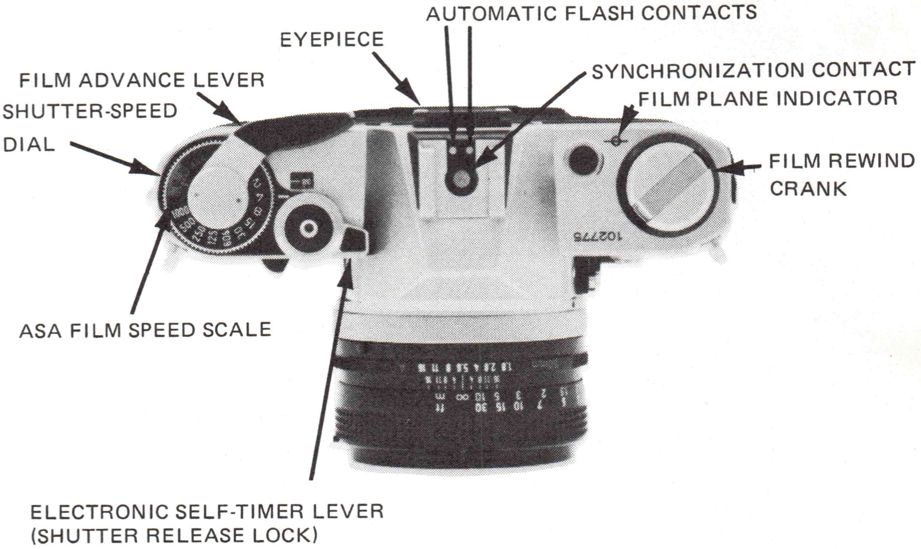
HOW IT WORKS

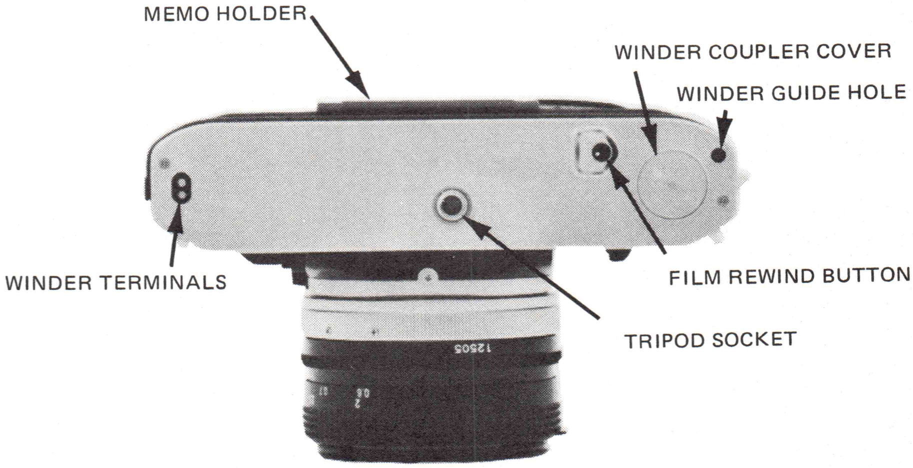
The AE-1 fits your hands comfortably and your fingers quickly learn the control locations and find them convenient to use. The controls, naturally, are pushbuttons, levers and dials because that's what fingers operate.

Just inside the camera body, the mechanical movement of most controls is changed immediately into an electrical signal. The heart of the camera is a Central Processing Unit—CPU in computer lingo. When you advance film and press the two-stage shutter button, here's what happens:

As the shutter button moves downward, it closes one circuit first and then closes another. The first closure turns on the exposure-measuring system which measures light coming through the lens, using a silicon sensor. The electronics work instantly. When the


FLASH HOT SHOE
SHUTTER RELEASE BUTTON
BATTERY CHECK BUTTON
FLASH TERMINAL
FILM SPEED SET RING
BACKLIGHT CONTROL SWITCH
EXPOSURE PREVIEW SWITCH
BATTERY CHAMBER COVER
STOPPED-DOWN LEVER
Canon
AE-1


AUTOMATIC FLASH CONTACTS
EYEPIECE
SYNCHRONIZATION CONTACT
FILM ADVANCE LEVER
FILM PLANE INDICATOR
SHUTTER-SPEED DIAL
FILM REWIND CRANK
ASA FILM SPEED SCALE
ELECTRONIC SELF-TIMER LEVER (SHUTTER RELEASE LOCK)


MEMO HOLDER
WINDER COUPLER COVER
WINDER GUIDE HOLE
WINDER TERMINALS
FILM REWIND BUTTON
TRIPOD SOCKET

AE-1 SPECIFICATIONS

Type: 35mm single-lens reflex AE (Automatic-Exposure) camera with focal-plane shutter, quick-return mirror and Canon Breech-Lock lens mount.

Standard Lenses: Canon FD 50mm *f*-1.4 S.S.C., Canon FD 50mm *f*-1.8 S.C.

Interchangeable Lenses: FD series: AE (Automatic Exposure) photography. FL series: Stopped-down metering with automatic disphragm operation. R series: Stopped-down metering with manual diaphragm operation.

Viewfinder: Fixed eye-level pentaprism. Standard eyepiece is −1 diopter.

Viewfinder Information: Aperture scale with meter needle, over-exposure warning marks, stopped-down metering and battery-check index mark, flashing red LED indicates underexposure and outside of meter coupling range. Flashing red M indicates camera is in manual mode.

Viewfinder Attachments: Angle finders, magnifier, eyecup and 10 Dioptric Adjustment Lenses from -4 to +3 diopters.

Focusing Screen: Similar to Screen E, page 149: Center split-image/microprism rangefinder surrounded by matte screen with Fresnel lens.

Field of View: 93.5% vertical, 96% horizontal of actual picture area. 0.86x magnification with standard 50mm lens at infinity.

Self-Timer: Set by moving lever forward around shutter button. Shutter delayed 10 sec. after pressing shutter release button. LED flashes while self-timer is operating.

Film-Speed Range: ASA 25–3200.

Exposure Adjustment & Meter: Shutter-preferred AE (Automatic Exposure) photography with FD series lenses. Aperture adjusted automatically after ASA and shutter speed are set. Silicon photocell used with central-emphasis metering system.

Exposure-Meter-Coupling Range: With ASA 100 film, EV 1—EV 18 (*f*-1.4 at 1 sec. to *f*-16 at 1/1000 sec.).

Backlight Control Switch: +1.5 *f*-stops for backlighting.

Battery: One 6V (544) silver-oxide battery.

Flash Synchronization: X (electronic flash) sync at 1/60 sec. and slower. FP, M, MF bulbs sync at 1/15 sec. or slower.

Flash Connections: Hot shoe has contacts for Canon Speedlite 155A and for conventional electronic-flash units. PC socket provided at front of camera body.

Speedlite 155A & Special Flash Circuit: Automatic thyristor-controlled electronic flash provides choice of two apertures, automatically selects aperture and sets shutter speed to 1/60 (regardless of shutter-speed setting) when Speedlite 155A is mounted.

Frame Counter: S-1-38; automatically resets to S when back cover is opened, counts backward sequentially as film is rewound. Counter does not advance on multiple exposures.

Multiple Exposures: Follow procedure on page 171.

Film Loading: Uses multi-slot take-up spool. Accepts any standard 35mm film roll in cartridge.

Film-Advance Lever: Single or multiple-stroke, 120° throw, 30° stand-off.

Film Rewind: Uses rewind button and crank.

Dimensions: Body only: 141 x 87 x 47.5mm (5-9/16" x 3-7/16" x 1-7/8"). 141 x 87 x 99.5mm (5-9/16" x 3-7/16" x 3-7/8") body with FD 50mm *f*-1.4 lens.

Weight: Body only: 590g (1.31 lbs.); with FD 50mm *f*-1.4 lens: 895g (1.97 lbs.).

Specifications subject to change without notice.

light is EV 1, the camera takes only 0.04 second to measure the light and calculate exposure. With more light, it does it faster!

You don't have to wait. If you depress the shutter button in one continuous movement to make the second switch closure before the camera is ready, the electronics will automatically prevent error. The computer will complete the exposure calculation before going to the next step.

Pushing the shutter button all the way down starts the exposure sequence. Exposure is calculated and stored in computer memory. It will not change after the exposure sequence begins. Under computer control, the lens aperture is stopped down to the desired value.

When lens aperture is correct for the selected shutter speed, the mirror moves up and the first curtain of the focal-plane shutter opens. When the first curtain is fully open, the X contacts of the flash-firing circuit close. Shutter-open time is controlled electronically as selected by the shutter-speed dial. When the desired amount of time has elapsed, the computer signals the second shutter curtain to close, ending exposure.

When film is advanced, all the electronic and mechanical systems of the camera are reset and all data accumulated during the last exposure is dumped. Now the camera is ready to do it again.

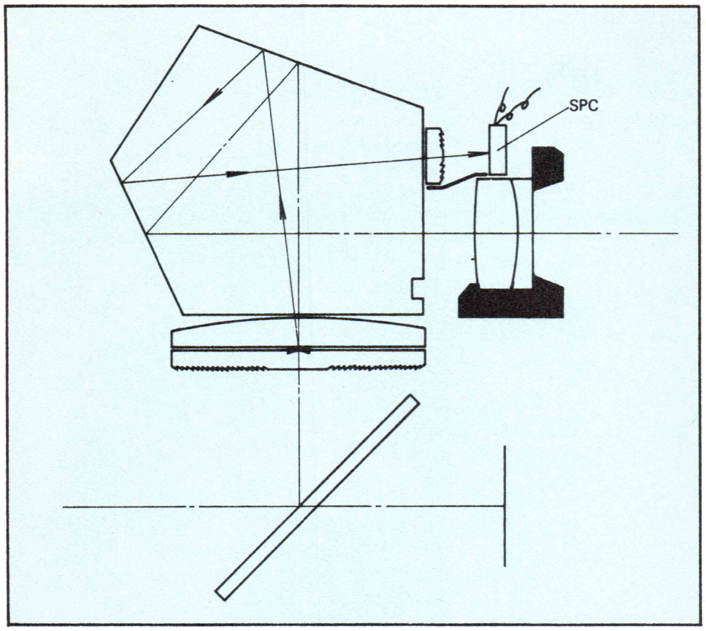
The camera will measure the light and set aperture automatically at any shutter-speed setting except B. At B, the camera cannot compute an aperture setting because it has no way of "knowing" how long you will hold the shutter open.

AE-1 FLASH SYNCHRONIZATION

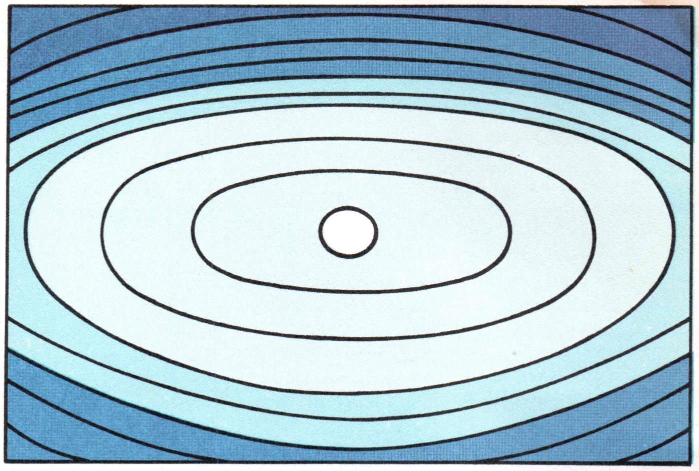
TYPE	SHUTTER SPEED
199A	1/60
155A	1/60
A-33	1/60 or slower
AB-46	1/60 or slower
AB-56	1/60 or slower
133D (non-auto)	1/60 or slower
Flashbulbs: M, MF, FP	1/15 or slower

It goes to maximum aperture and flashes an LED warning light in the display.

Metering—The silicon photo sensor is near the eyepiece of the viewing system. It "looks" at the same image you do, on the viewing screen, but is strongly center-weighted. Because of the strong Central Emphasis in the metering



Silicon Photocell (SPC) in AE-1 camera is above viewing eyepiece. It "looks at" the image on the focusing screen and is strongly center weighted, which Canon calls Central Emphasis.



Starting with maximum sensitivity in the center, sensitivity pattern for AE-1 meter shows strong central emphasis. Each zone represents one exposure step, so main reading is taken in central band and slightly below center.

ASA 25 • • 50 • • 100 • • 200 • • 400 • • 800 • • 1600 • • 3200
(32) (40) (64) (80) (125) (160) (250) (320) (500) (650) (1000) (1250) (2000) (2500)

There isn't enough room on the film-speed dial to show all settings. Figures in parentheses appear as dots on the dial.

pattern, the metering area is a band about 1/3 of the viewing screen height and about 2/3 the width. Anything outside of this area will not affect the meter reading unless it is a very bright light source.

The camera is designed for open-aperture metering with an FD lens. With an FD lens mounted directly on the camera, stopped-down metering is not possible. With any lens not designed for open-aperture metering, or with FD lenses separated from the camera by accessories which do not couple the lens mechanically to the camera, stopped-down metering is accurate.

The focusing aid is a biprism, surrounded by a microprism, surrounded by ground glass. This screen is standard and not interchangeable. A meter needle moves along an *f*-number scale on the right side of the screen, indicating the *f*-stop the camera will use to make the exposure automatically.

Any time the camera is being operated so it does not control lens aperture automatically, a red LED (Light-Emitting Diode) indicator flashes at the top of the display, illuminating a red M which means you must set aperture manually. The exposure display continues to work the same way, except for the flashing M. The meter needle *does not* indicate manually-selected apertures as you rotate the aperture ring on the lens.

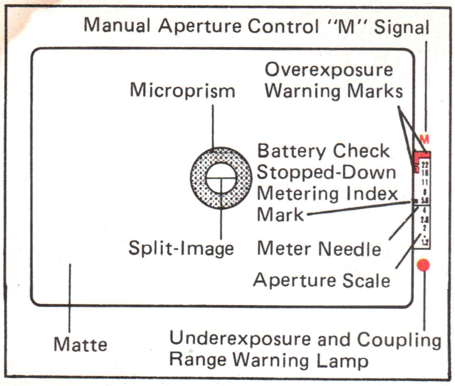
When operating the camera on manual, consider the exposure display as a separate exposure meter which you can read to help decide what aperture to set at the lens.

Two red bands at the top of the *f*-number scale indicate overexposure. The band near *f*-16 is used with lenses having minimum aperture of that value; the band near *f*-22 is used with lenses which stop down to *f*-22.

If the needle enters the red band near *f*-16 while you are preparing to shoot, that means the camera wants to use an aperture smaller than *f*-16 but smaller aperture is not available on the lens. Change to a faster shutter speed to move the needle out of the red zone. When using a lens with *f*-22, follow the same procedure using the other band.

A few Canon lenses have *f*-32 aperture settings. If you are using one and the light is bright enough to drive the needle into the overexposure band for an *f*-22 lens, do this: Use faster shutter speed to move the needle out of the *f*-22 red band. Then switch to the next slower shutter speed, disregard the meter indication.

At the bottom of the *f*-number scale is a red flashing LED indicator—the Underexposure and Coupling Range Warning Lamp. It tells you something is wrong. It's up to you to figure out which of several possibilities. The LED flashes to warn of underexposure. Switch to a slower shutter speed. If the light stops flashing, that was the problem. It flashes to indicate control settings beyond the meter coupling range and the meter needle goes off-scale at the bottom. Consult the accompanying Meter


Manual Aperture Control "M" Signal
Overexposure Warning Marks
Microprism
Battery Check Stopped-Down Metering Index Mark
Split-Image
Meter Needle
Aperture Scale
Matte
Underexposure and Coupling Range Warning Lamp

Viewfinder display of AE-1 gives full information about what's happening except for shutter speed. However you choose shutter speed beforehand, so you should know what it is.

AE-1 METER COUPLING RANGE	
ASA Film Speed	**Coupling Range**
25–50	2 to 1/1000 sec.
100	1 to 1/1000 sec.
200	1/2 to 1/1000 sec.
400	1/4 to 1/1000 sec.
800	1/8 to 1/1000 sec.
1600	1/15 to 1/1000 sec.
3200	1/30 to 1/1000 sec.

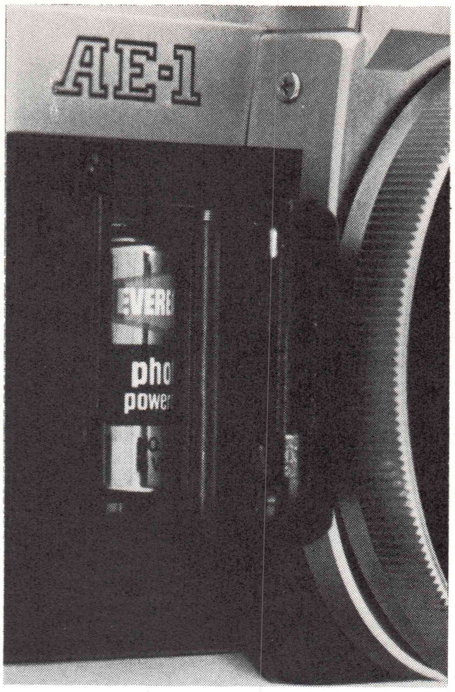
Coupling Range Table. The LED flashes when the camera exposure computer wants larger aperture than the lens can provide. For example, if you are using an *f*-4 lens and the computer needs an aperture setting of *f*-2, the light will flash. Compare the *f*-number indicated by the meter needle to the maximum *f*-stop of the lens and you'll see the problem. If you select B on the shutter-speed dial with the camera set for automatic, the needle drops below scale and the LED blinks. Change to another shutter speed.

The warning lamp at the bottom of the *f*-number scale may flash to indicate a problem with Speedlite 155A or 199A. When the 155A is controlling the camera, as described in Chapter 16, it selects one of two apertures according to where you position the RED-GREEN switch on the back of the flash unit. If you set the flash to demand larger aperture than the lens has, the LED warning lamp will blink. Example: Using ASA 25 film, the aperture choices are *f*-28 (Green) and *f*-1.4 (Red). If you are using an *f*-1.8 lens, and switch the RED-GREEN control to RED, the lamp will blink because that lens won't go to *f*-1.4.

Camera Controls—The controls are similar to other Canon SLR's with a few exceptions. Use your left hand to focus the lens. Use your left thumb to operate the three controls on the left-hand side of the lens. The lower of these is the Stopped-Down Lever. When this control is pushed in, a small chrome button springs up from underneath it, locking the lever in. I use a fingernail to depress the chrome button to release the lever.

Just above the Stopped-Down Lever is the Exposure Preview Switch. This turns on the meter circuit in the camera. If you want to see what *f*-stop the camera will select for a particular scene, focus, then depress the Exposure Preview Switch. The meter needle will point to an *f*-stop for as long as you hold the switch closed. If you want to read scene brightness at different locations, use this switch to do it.

When depressed halfway, the shutter button also turns on camera metering, so you have two ways to do it. When you are doing something with one hand, you always have a way to turn on the camera meter with the other hand. In normal operation, focus with the left hand, turn on the meter with right index finger. If this gives you an *f*-stop you don't want, or if the meter indicates improper exposure, the correction is shutter speed. It is not convenient to change shutter speed with your right index finger while also depressing the shutter button to see the reading. Use your left thumb on the Exposure Preview Button while changing shutter speed. This quickly becomes a natural reflex when using the AE-1 and you'll find that having two ways to turn on the camera meter is very useful.



A 6-volt #544 silver oxide battery powers the camera for about a year, or 20,000 exposures. Frequent use of the time-exposure capability or excessive use of the exposure preview switch will shorten battery life.

Unless one of these two buttons is depressed, the camera electronics are turned off. This conserves battery power and makes a camera on-off switch unnecessary.

Above the Exposure Preview Button is another smaller button which feels different to your thumb. This is the Backlight Control Switch. Depress it to get 1.5 steps more exposure, with the camera on automatic, that it would normally give. This is to get correct fact tones when making a portrait against sky background and similar backlit situations.

The shutter-speed dial is knurled and slightly overhangs the camera body at the front. This makes it easy to change shutter speeds with your right index finger without taking your eye from the viewfinder.

Battery Compartment Cover—The outer edge of this door on the front of the camera body is raised to form a grip for the fingers of your right hand.

A plastic rectangle comes with the camera to serve as a hot-shoe cover or a viewfinder cover when you are shooting with your eye away from the window. This has a small projection you can use to open the battery-compartment door. You can also do it with a paperclip or your fingernail.

The battery compartment is marked to show battery polarity: + on top. The lower battery contact is spring-loaded. Push downward on the battery and it comes out easily. Load a new one the same way. Remove the lens when changing batteries and it will be easier because the door opens wider.

Battery Check—The battery-check button is on top of the camera, near the rewind knob. With a fresh battery, when you depress the button, the meter needle in the viewfinder should point to *f*-2.8. As the battery is used, the reading will drift toward *f*-5.6. At or just before the meter needle reaches the index at *f*-5.6, replace the battery with a new one. If battery voltage gets too low, the camera becomes inoperative.

Stopped-Down Metering – The Stopped-Down Lever won't operate with an FD lens installed and the lens set to automatic. With the lens switched off automatic, the camera won't prevent you from using the stopped-down metering procedure but it will be inaccurate.

With a lens not designed for open-aperture metering such as an FL, or when an FD lens is separated from the camera by extension tubes or bellows so the full-aperture metering linkage no longer operates, you can meter stopped-down:

Advance the film and get the camera ready to shoot.

Push the Stopped-Down Lever all the way in.

Adjust aperture or shutter speed until the meter needle aligns with the special stopped-down index mark near *f*-5.6 in the display.

Operate the shutter button.

Release the Stopped-Down Lever.

EXCEPTION: The following lenses can be used on the AE-1 camera but stopped-down metering *will not be accurate* because these lenses depress the Lens Speed Adjustment Pin in the camera body. This causes the camera to think you have an FD lens installed and it will meter inaccurately. These are all old lenses, no longer in production.

FL 19mm *f*-3.5
FL 35mm *f*-2.5
FL 50mm *f*-1.8
FL 58mm *f*-2.5
R 35mm *f*-2.5
R 50mm *f*-1.8
R 100mm *f*-2

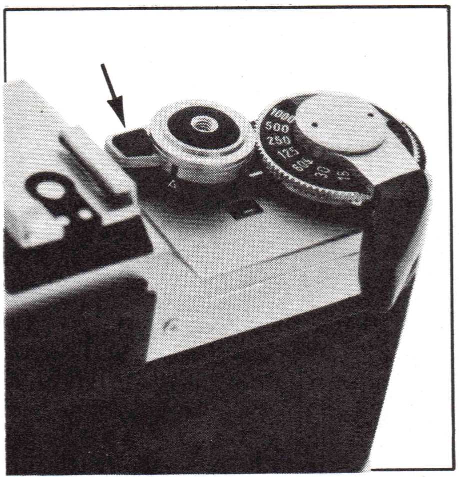
Viewing Depth of Field—Stopping down an FD lens with the AE-1 camera is complicated by the way camera and lens work together as described in Chapter 10.

To view depth of field with an FD lens:

Advance the film with the camera on automatic, focus, and notice the *f*-stop the camera indicates.

Take the lens off automatic and set it to the *f*-stop indicated by the camera display.

Push the Stopped-Down Lever all the way in.



Ring around shutter button is operated by handle (arrow). When index mark on ring points to A as shown, shutter button can be depressed and camera operates normally. Move ring to L to lock the shutter button so you can not accidentally depress it.

Ignore the meter reading—it is not correct.

If depth of field is not satisfactory, change aperture as needed and make compensating changes in shutter speed. Continue to ignore the meter.

When you get it right, depress the shutter button.

Release the Stopped-Down Lever.

Put the lens back on the automatic setting.

Advance the film.

CAUTIONS: If you follow this procedure without first advancing film to get a fresh frame in place, you may not see correct depth of field. Lens will not stop down to an aperture smaller than the aperture used on the previous exposure.

If it is necessary to put the camera back on automatic without operating the shutter, rotate the lens aperture control ring all the way to maximum aperture first, then set it on automatic.

Using the Self-Timer and Shutter Lock—A collar around the shutter button has three positions, selected by moving the handle on the collar. When positioned at L, the shutter button is locked and cannot be depressed. This prevents accidental exposures and should be the usual position of the control. When set to A, the shutter button can be used.

In some Canon models with a shutter-lock lever, the shutter can be locked open for time exposures. With the AE-1 the lock cannot be used after the shutter button has been depressed. To make time exposures, use a locking cable release and the B setting.

If the self-timer is set to operate and the shutter button held down continuously by a locking cable release, the self-timer serves as an interval timer. Every ten seconds it will automatically expose one frame. With Power Winder A to advance the film, this is a simple way of doing time-lapse photography—but only at ten-second intervals.

When the handle is moved fully

forward, the index mark on the collar points to the symbol S, and a red LED lamp becomes visible. This is the setting for use of the self-timer. Start the timer by depressing the shutter button after the camera is set up to shoot. Exposure settings are locked in the camera computer at the instant the shutter button is depressed. A delay of 10 seconds is timed electronically, then the shutter operates. The LED indicator flashes at 2 times per second to indicate the self-timer is counting down.

If you return the self-timer lever to the off position while the count-down is progressing, the shutter will operate immediately.

To cancel the self-timer, depress the battery-check button. Then you can return the self-timer lever to the off position without firing the shutter. Or you can start the timer again by depressing the shutter button once more. If you do, the timer countdown starts over and you get the full 10 seconds delay.

Holding an Exposure Reading—The AE-1 doesn't have any special control to hold exposure readings when doing substitute metering. There are two ways:

While metering on the substitute surface, start the self-timer. This holds the reading at the instant the timer started. Then point the camera to the scene you intend to shoot and wait out the self-timer delay. When the shutter operates it will be at the exposure setting determined by metering the substitute surface.

Or, while metering on the substitute surface, notice the *f*-stop the camera plans to use. Take it off automatic, set the lens at that *f*-stop, take the picture.

Overriding the Camera—While metering on the scene you intend to shoot, you may want more or less exposure because the scene is not average—unusually bright or dark backgrounds, for example. There are three ways to take charge of the camera.

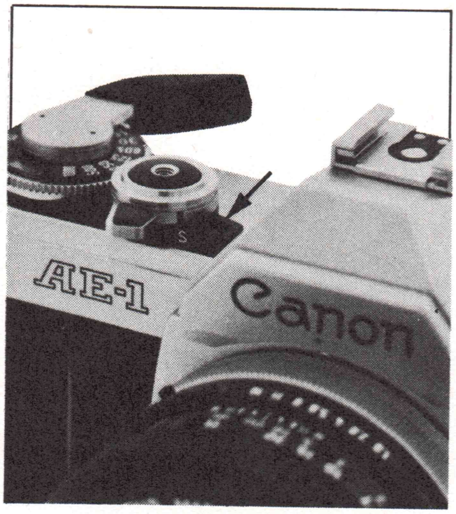
If the subject is backlit, use the Backlight Control Switch without taking the camera off automatic. This gives 1.5 steps more exposure than the camera would otherwise use.

Or, notice what setting the camera plans to use on automatic. Take it off auto and use whatever setting you want.

Or, leave the camera on automatic but change the ASA film-speed setting so the camera gives more or less exposure than it would with correct ASA setting. To give one step more exposure, reduce ASA setting to half.

Getting in the Ballpark—An inexperienced photographer may have a problem selecting a shutter speed that will bring the meter needle on scale in the camera. For a preliminary setting:

Indoors	use	1/30 or 1/60
Average outdoors	use	1/125 or 1/250
Bright outdoors such as snow or beach	use	1/500 or 1/1000



When ring around shutter button is moved to S, self-timer is set to operate. Start it by depressing shutter button. Exposure setting is memorized at that instant although shutter opening is delayed for 10 seconds. Countdown is indicated by red LED lamp (arrow) which blinks two times per second.

If aperture seems unsuitable at the indicated shutter speed, change shutter speed. If necessary use film with a different ASA rating.

Rewinding Film—When you have shot 20 or 36 exposures, depending on which you loaded, depress the rewind button on the bottom of the camera. Tilt up the rewind crank and turn as indicated by the arrow. After a turn or so, the rewind button will stay depressed without your finger on it.

Notice the frame counter. It counts backwards as you rewind. When you reach S on the frame counter, open the camera back. Rewind a little farther if necessary and remove the film cartridge from the camera with the film end still out of the cartridge—unless you want to wind it all the way in.

Multiple Exposures—There is no "official" way to make multiple exposures with the AE-1. An "unofficial" way that usually works is as follows:

Make exposure #1. Rotate rewind knob to remove slack in film path. Hold knob that way. Depress rewind button on camera bottom. Hold it down. Operate film-advance lever one full stroke. Release everything. Make next exposure. Film registration may change from shot to shot with this procedure. Also the rewind button on the bottom of the camera may stay depressed of its own accord, forcing you to make three exposures before the film will start advancing again. If you only intend two exposures, put on the lens cap for the third.

The frame counter will not advance during multiple exposures.

Mirror Lock-up—The AE-1 has no provision to lock up the mirror. I consider mirror lock-up and use of a cable release important only when a camera is used on a tripod. When hand-holding, mirror lock-up is useless because you can't see anything in the viewfinder. This is another indication of the essential nature of the AE-1. It is designed for rapid-fire hand-held automatic photography, for which mirror lock-up is not needed.

THE AT-1 CAMERA

The AT-1 is basically a modified AE-1 with non-automatic match-needle exposure control. The main differences are metering, viewfinder display, ON-OFF switch and exposure control.

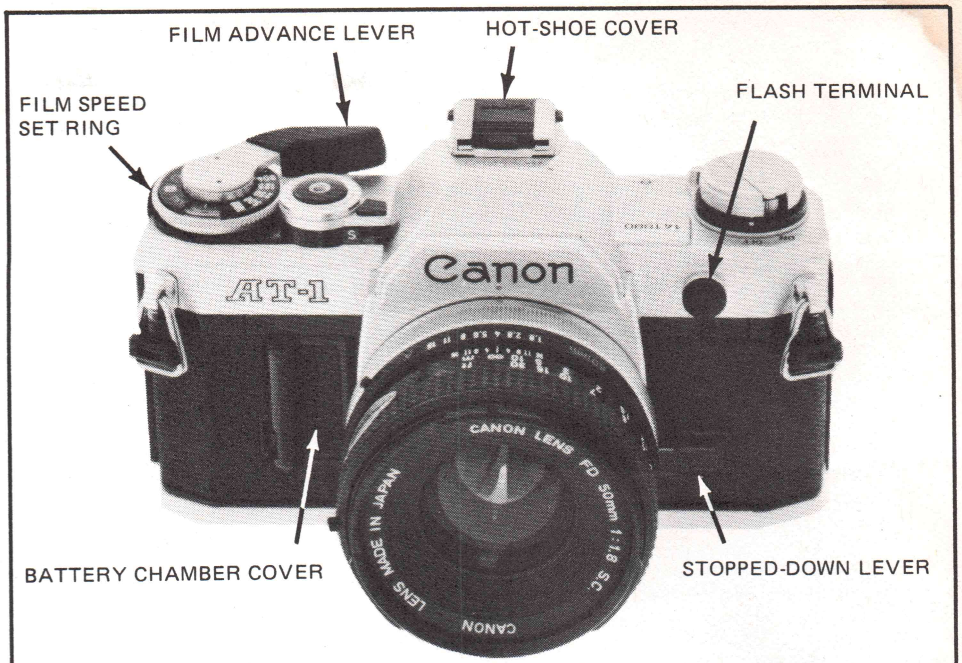
All other features of the AE-1 are preserved, including the electromagnetic shutter release, electronic control of the camera shutter mechanism, electronic self-timer that can be canceled, compatibility with Power Winder A and a limited compatibility with Speedlite 155A and 199A.

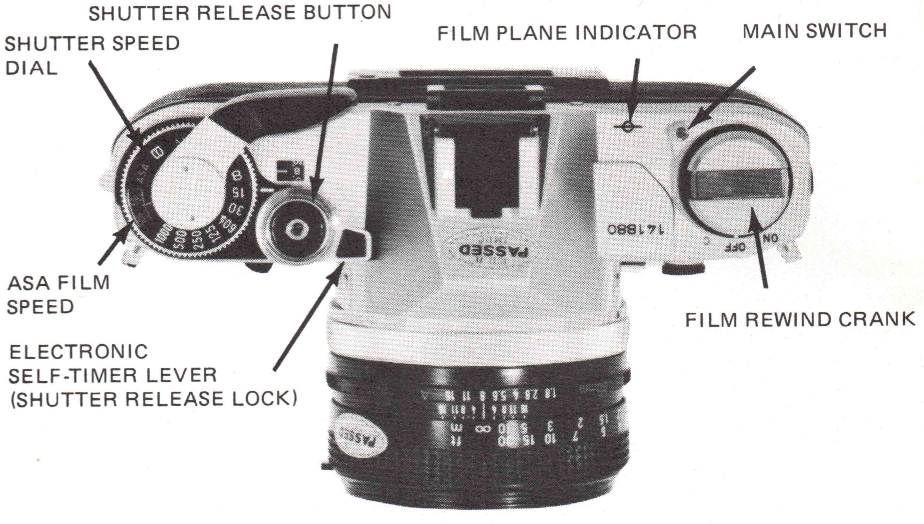
Even though the AT-1 costs less, a buying decision should be made on the basis of camera operating features rather than cost alone. The AT-1 is suited for the person who doesn't need automatic-exposure control or perhaps even prefers not to have it. "Leaving out" the automatic-exposure feature has some side benefits which increase the utility of the camera to some photographers.

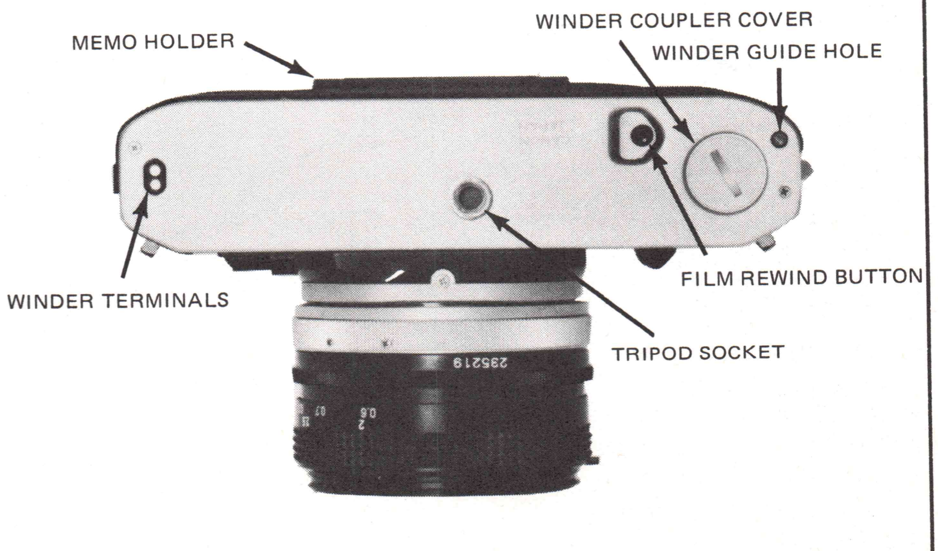
Here are a couple of things the AT-1 does more conveniently: Substitute metering is easy and straightforward with the AT-1. Just point at the substitute metering surface, set the exposure controls, then point at the scene you intend to shoot, and take the picture. The exposure controls stay where you put them. With the AE-1, substitute metering is done either with the self-timer or by taking the camera off automatic.

With the AT-1 you can deliberately mismatch the needles to give either more or less exposure than the camera's exposure meter suggests. You can give more exposure for backlit portraits, less exposure for a light subject against a dark background, or any kind of exposure adjustment you want to use—in any amount.

Of course there are advantages in other A-series cameras that the AT-1 can't match. The point is, consider the AT-1 as a camera of equal stature, but with different features.


FILM ADVANCE LEVER
HOT-SHOE COVER
FILM SPEED SET RING
FLASH TERMINAL
Canon
AT-1
CANON LENS FD 50mm 1:1.8 S.C.
BATTERY CHAMBER COVER
STOPPED-DOWN LEVER


SHUTTER RELEASE BUTTON
SHUTTER SPEED DIAL
FILM PLANE INDICATOR
MAIN SWITCH
ASA FILM SPEED
ELECTRONIC SELF-TIMER LEVER (SHUTTER RELEASE LOCK)
FILM REWIND CRANK
PASSED


MEMO HOLDER
WINDER COUPLER COVER
WINDER GUIDE HOLE
WINDER TERMINALS
FILM REWIND BUTTON
TRIPOD SOCKET

AT-1 SPECIFICATIONS

Type: 35mm single-lens reflex camera with focal-plane shutter, quick-return mirror and Canon Breech-Lock lens mount.
Standard Lenses: Canon FD 55mm *f*-1.2 S.S.C., Canon FD 50mm *f*-1.4 S.S.C., Canon FD 50mm *f*-1.8 S.C.
Interchangeable Lenses: FD series: Full-aperture metering. FL series: Stopped-down metering with automatic diaphragm operation. R series: Stopped-down metering with manual diaphragm operation.
Viewfinder: Fixed eye-level pentaprism. Standard eyepiece is –1 diopter.
Viewfinder Information: Meter Needle and Aperture Needle visible on right side of viewfinder image. Upper and lower metering-limit index marks. Upper index mark also serves as battery-check index.
Viewfinder Attachments: Angle Finders A2 and B, Magnifier S, Dioptric Adjustment Lenses S in 10 strengths from -4 to +3, and Eyecup 4S.
Focusing Screen: Similar to Screen E, page 149: Center split-image/microprism surrounded by matte screen with Fresnel lens.
Field of View: 93.5% vertical and 96.3% horizontal of actual picture area. 0.86x magnification with standard 50mm lens set at infinity.
Self-Timer: Set by moving lever forward around shutter button. Shutter delayed 10 sec. after pressing shutter-release button. LED flashes while self-timer is operating. Timer can be canceled by turning off camera main switch.
Film-Speed Range: ASA 25–3200.
Exposure Meter: Built-in CdS sensor meters through-the-lens at full aperture with FD-series lenses. Metering pattern is Central Emphasis.
Exposure-Meter Coupling Range: With ASA-100 film, EV 3 to EV 17, assuming *f*-1.4 lens.
Battery: One 6V silver-oxide battery—Eveready #544, UCAR #544, JIS 4G13 or Mallory PX28. Battery should last for 20,000 shutter operations, or one year under normal use.
Flash Synchronization: X (electronic flash) sync at 1/60 sec. and slower. With Speedlite 155A used in automatic mode, shutter speed is automatically set to 1/60. M, MF and FP flashbulbs can be used at 1/15 or slower—in some cases 1/30 or slower.
Flash Connections: Hot shoe has contacts for Canon Speedlite 155A and for conventional flash units. PC socket provided at front of camera body.
Speedlite 155A and Special Flash Circuit: Speedlite 155A works through special contact on camera hot shoe to set camera shutter speed to 1/60 automatically when Speedlite ready light is on.
Frame Counter: S-1-38; automatically resets to S when back cover is opened, counts backward sequentially as film is rewound. Counter does not advance on multiple exposures.
Multiple Exposures: Follow procedure on page 176.
Film Loading: Open back by lifting up rewind crank. Uses multi-slot take-up spool. Accepts any standard 35mm film cartridge.
Film-Advance Lever: Single or multiple-stroke, 120° throw, 30° stand-off position.
Film Rewind: Uses rewind button and crank.
Dimensions: Body only: 141 x 87 x 47.5mm (5-9/16" x 3-7/16" x 1-7/8"). 141 x 87 x 99.5mm (5-9/16" x 3-7/16" x 3-7/8") body with FD 50mm *f*-1.4 lens.
Weight: Body only: 590 g (1.31 lbs.); with FD 50mm *f*-1.4 lens: 895g (1.97 lbs.).

Specifications subject to change without notice.

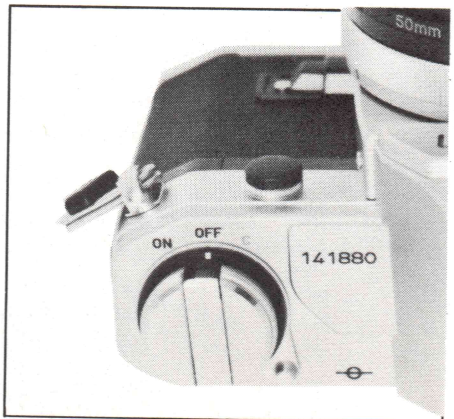
ASA	25	• •	50	• •	100	• •	200	• •	400	• •	800	• •	1600	• •	3200
		(32) (40)		(64) (80)		(125) (160)		(250) (320)		(500) (650)		(1000) (1250)		(2000) (2500)	

There isn't enough room on the film-speed dial to show all settings. Figures in parentheses appear as dots on the dial.

Main Switch—Concentric with the Film Rewind Crank is the Camera Main Switch which has three positions: ON, OFF and C which is used to check the battery. The Main Switch must be ON to operate the camera because the shutter is controlled electronically. When not using the camera, be sure this switch is OFF to guard against wasting battery power and premature battery failure. The Main Switch is the *only* control that turns off the camera.

Loading the Battery—The battery-compartment door has a raised edge to serve as a convenient finger grip when holding the camera. The plastic hot-shoe cover has a small projection which can be used to release the latch of the battery-compartment door. You can also open it with your fingernail or any small tool.

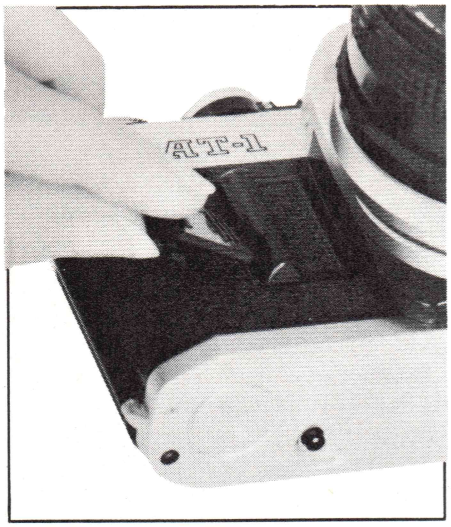
The 6-volt silver-oxide battery is inserted with the positive terminal toward the top of the camera. To load, place the negative end of the battery against the raised metal terminal post in the bottom of the compartment. With the battery still tipped outward at the top, press down on the battery. The bottom terminal is spring-loaded and will move downward, allowing room to complete battery insertion.



This is the only switch that turns off the camera electronics. To avoid wasting battery power, be sure to turn the camera OFF when not in use.

Battery Life—The battery will last for about 20,000 exposures or for about one year of normal use. Battery consumption is increased if the camera is used often or for long periods with the shutter set on B. When battery voltage becomes too low, the shutter will not operate. The cure is to replace the battery. A small holder for a spare battery comes with each AT-1 and is to be installed on the camera strap.

Battery Check—No special exposure-control settings are required to check the battery. Remove the lens cap, move the Main Switch to C, look into the viewfinder. If the Meter Needle moves upward to or above the V-shaped index mark at the top of the display,



To release the battery-compartment door-latch, use the hot-shoe cover.

the battery is OK. If it doesn't move that high, replace the battery.

Camera Controls–The knurled rim of the Shutter-Speed Dial extends to the front edge of the camera so it can be operated with your right index finger without removing the camera from your eye.

The same knurled edge is used to set in film speed by lifting up the rim of the Shutter-Speed Dial and rotating it until the desired film-speed number appears in the adjacent window.

Self-Timer–The self-timer lever serves also as a shutter-button lock when moved to the L position. Set the lever to A and the shutter button can be operated. Move the lever forward to the S position and the self-timer is set to operate. Start the self-timer sequence by depressing the shutter button. A small red LED lamp adjacent to the self-timer blinks twice a second during the ten-second delay before the shutter operates.

The self-timer can be canceled any time before the shutter operates by turning the camera Main Switch to OFF. Then flip the self-timer lever back to A or L. If you don't it will be set for self-timing again when you turn the camera back on.

With Power Winder A, the self timer can be used as an intervalometer. Turn on the power winder, set the timer, then hold down the shutter button with a locking cable release. The camera will make an exposure every 10 seconds until it runs out of film.

Viewfinder Display–The focusing aid is a biprism surrounded by a microprism. If you are used to either of these alone, you'll appreciate having both types together. The exposure display is a simple match-needle arrangement. The needle with the circle on the end–the Aperture Needle–is moved up or down in the display by lens-aperture setting, shutter speed, film-speed setting and the pin on the lens that signals maximum aperture size to the camera.

The straight Meter Needle responds *only* to the amount of light measured by the built-in light sensor because everything else that affects exposure is combined into the position of the Aperture Needle.

At the top and bottom of the display are two V-shaped index marks. Some Canon literature identifies the top mark as an Overexposure Warning Index Mark. It also serves as the battery-check index. The bottom mark is called Underexposure Warning Index Mark. These index marks are *metering limits* rather than over- or underexposure indicators. This is explained a little later in this discussion.

Overexposure and Underexposure–When the straight Meter Needle passes through the center of the circular opening in the Aperture Needle, exposure is correct for an average scene. The diameter of the circular part of the Aperture Needle is equal to one exposure step. Therefore if the Meter Needle is aligned with the top of the Aperture needle, you are giving a half-step more exposure.

If the Meter Needle is above the Aperture Needle, you are giving more exposure than the camera meter thinks you should. In that sense, you are overexposing. Therefore overexposure is always indicated when the Meter Needle is above the center of the Aperture Needle, no matter where these needles are in the display.

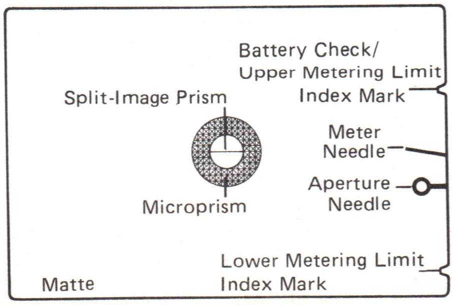
Similarly, underexposure is indicated when the straight needle is below the center of the circular needle, no matter where the needles are in the display.

Metering Limits–Because the Meter Needle is affected only by the amount of light reaching the CdS light sensor in the camera, the upper and lower light-measuring limits of the sensor can be shown in the viewfinder. These are the V-shaped Metering Limit Index marks at the top and bottom of the display.

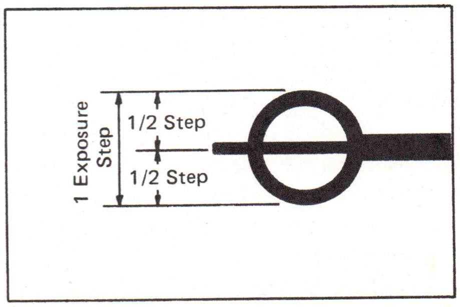
If the amount of light reaching the sensor becomes bright enough to drive the Meter Needle up to the top index mark, or higher, the meter reading will not be accurate. This will happen very rarely–it takes light on the scene that is about twice as bright as the sun.

If light on the sensor becomes dim enough so the Meter Needle falls to or below the bottom index

AT-1 VIEWFINDER DISPLAY



AT-1 MATCH-NEEDLES



mark, the meter reading will be inaccurate because the light level is less than the minimum requirement of the CdS sensor. When the light gets this dim, you can barely see the needles.

Meter Coupling Range—Canon cameras indicate the limits of metering accuracy or coupling range in various ways. Some show a red signal at the low-light limit of the coupling range. Some rely on meter-coupling tables published in the camera instruction booklet and also in this book.

The AT-1 instruction booklet includes a meter-coupling table but you don't need to use it. The Metering Limit Index marks in the camera viewfinder serve as your guide to meter-coupling limits. If you can match the needles in the display and still keep the straight Meter Needle between the upper and lower V-shaped index marks, you will meter accurately. This is a worthwhile simplification of meter-reading procedures.

It is possible to adjust the camera exposure controls so the Aperture Needle is positioned beyond the upper or lower meter coupling limit, as indicated by the V-shaped marks. For example control settings of ASA 25, *f*-16 and 1/1,000 second will position the Aperture Needle above the metering limit. Of course you can shoot with those settings, but don't expect metering accuracy even if you find enough light to drive the Meter Needle that high up the scale.

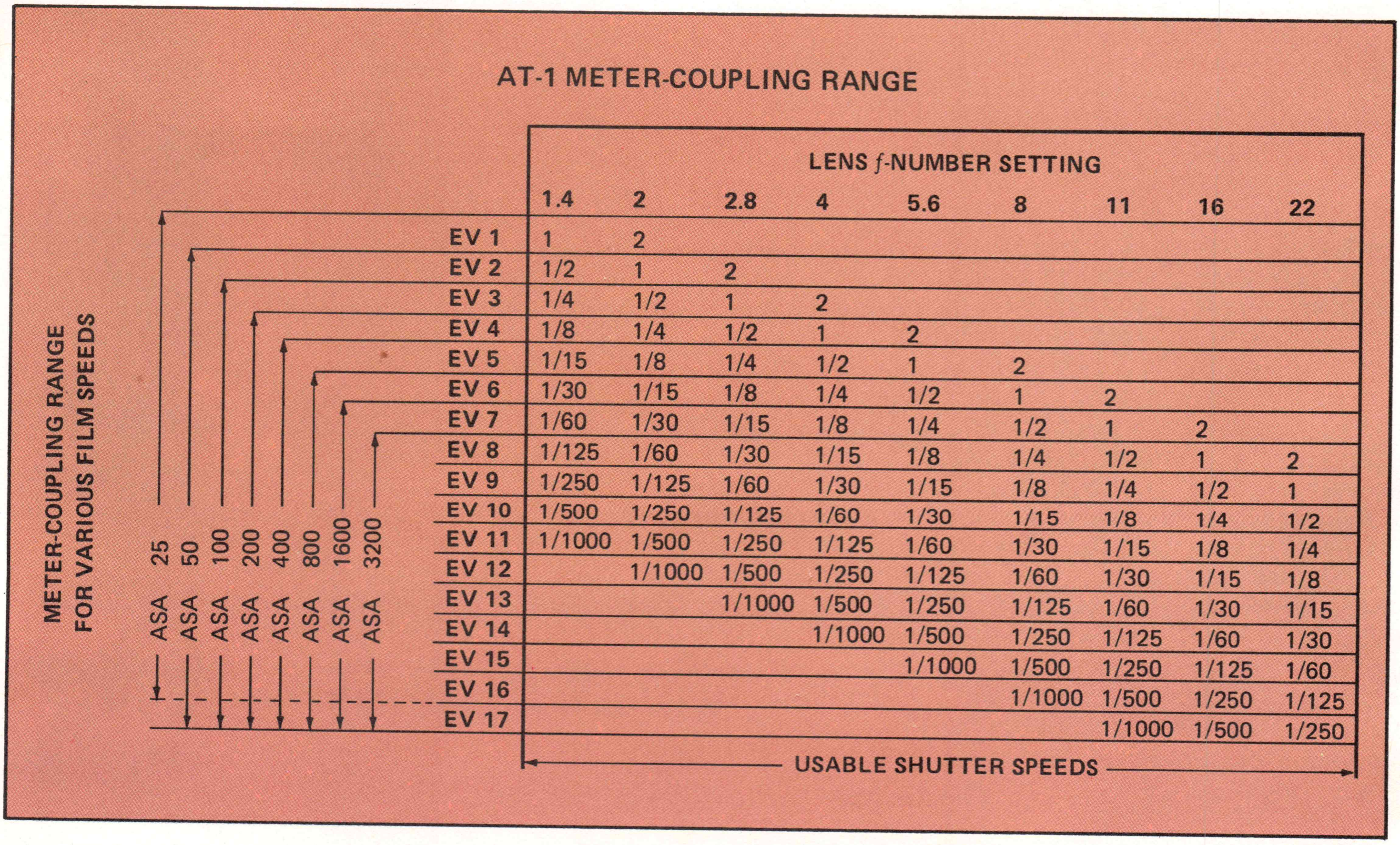
If you need to work outside the metering-accuracy limits, figure some way to do your metering within limits, then count exposure steps and work your way out to whatever setting you need.

Sensor Memory—The CdS sensor in the AT-1 has a "memory" which causes the reading to be too high if the sensor is in bright light and then suddenly used in dim light. Wait a minute or so in dim light before taking the reading. Also, in dim light, the sensor responds very slowly. You can watch the reading gradually change. For maximum reading accuracy, wait until the needle stops moving.

Metering Pattern—The AT-1 uses Central Emphasis metering, similar to the pattern shown earlier for the AE-1.

Stopped-Down Viewing—A slide-type Stopped-Down Lever is on the camera body, near the lens mount. It is convenient to operate it with your left thumb while cradling the lens in your left hand. When the lever is pushed toward the lens, the lens aperture is closed down to the f-stop selected on the aperture-control ring of the lens. A small chromed button pops up to lock the lever in the inward position. Depress the button and the lever slides back out again, allowing the lens aperture to become fully open.

Use this control to view depth of field at the aperture selected on FD and FL lenses. If you change the lens aperture setting with the Stopped-Down Lever pushed in, you can see depth of field change and you can quickly set aperture for the desired depth of field.


METER-COUPLING RANGE FOR VARIOUS FILM SPEEDS
ASA 25
ASA 50
ASA 100
ASA 200
ASA 400
ASA 800
ASA 1600
ASA 3200

AT-1 METER-COUPLING RANGE

	LENS *f*-NUMBER SETTING								
	1.4	2	2.8	4	5.6	8	11	16	22
EV 1	1	2							
EV 2	1/2	1	2						
EV 3	1/4	1/2	1	2					
EV 4	1/8	1/4	1/2	1	2				
EV 5	1/15	1/8	1/4	1/2	1	2			
EV 6	1/30	1/15	1/8	1/4	1/2	1	2		
EV 7	1/60	1/30	1/15	1/8	1/4	1/2	1	2	
EV 8	1/125	1/60	1/30	1/15	1/8	1/4	1/2	1	2
EV 9	1/250	1/125	1/60	1/30	1/15	1/8	1/4	1/2	1
EV 10	1/500	1/250	1/125	1/60	1/30	1/15	1/8	1/4	1/2
EV 11	1/1000	1/500	1/250	1/125	1/60	1/30	1/15	1/8	1/4
EV 12		1/1000	1/500	1/250	1/125	1/60	1/30	1/15	1/8
EV 13			1/1000	1/500	1/250	1/125	1/60	1/30	1/15
EV 14				1/1000	1/500	1/250	1/125	1/60	1/30
EV 15					1/1000	1/500	1/250	1/125	1/60
EV 16						1/1000	1/500	1/250	1/125
EV 17							1/1000	1/500	1/250

USABLE SHUTTER SPEEDS

AT-1 FLASH SYNCHRONIZATION	
TYPE	SHUTTER SPEED
199A	1/60 or slower
155A	1/60
A-33	1/60 or slower
AB-46	1/60 or slower
AB-56	1/60 or slower
133D (non-auto)	1/60 or slower
Flashbulbs	1/30 or slower

Stopped-Down Metering—Whenever an FD lens is set on A for full-aperture metering, *do not* use the stopped-down metering. This is the case when an FD lens is attached to the camera directly or through accessory devices which preserve automation, such as Extension Tubes FD 25 and FD 50. You can operate the controls to get a stop-down meter reading in these cases, *but the reading will not be accurate.* The camera is designed for full-aperture metering with FD lenses, which is more convenient anyway.

When using a lens or a lens-and-accessory combination that does not allow full-aperture metering, stopped-down metering is OK and accurate. This is the case with an FL or FD lens attached to the camera through a bellows or non-automatic extension tube.

When stopped-down metering is necessary, the camera allows you to do it. Among Canon cameras, the AT-1 is unusual when performing stopped-down metering. You match needles the same way as in full-aperture metering. There is no special stopped-down metering index mark in the display and no special metering procedure. Just push in the Stopped-Down Lever and match the needles.

A few early FL and R-type lenses that are no longer in production will give incorrect readings when used with stopped-down metering on the AT-1 or AE-1. The reason is given on page 167 along with a list of applicable lenses.

Flash Synchronization—The hot shoe has a center contact to fire any standard electronic or bulb-type flash unit inserted in the shoe. It also has a single auxiliary contact—called Automatic Flash Contact— for use with the special Canon Speedlite 155A or 199A. Through this auxiliary contact, the flash automatically switches the camera to a shutter speed of 1/60 second—X-sync speed for the AT-1—whenever the ready light is on. This happens no matter where the AT-1 Shutter-Speed Dial is set, with the exception of B.

The hot shoe is switched on by insertion of a flash unit. The flash terminal on the camera body is provided with a plastic cover which should be in place except when the terminal is being used.

The camera provides X-sync only, which appears at the hot shoe and the flash terminal on the camera body. By placing one flash unit in the hot shoe and cord-connecting another to the camera body, you *can* fire two flash units simultaneously but the procedure is *not* recommended. It doubles the current load on the camera's internal flash contacts and may damage them. Recommended procedure is to use a single flash only. Optical slave units are available to fire as many additional flash units as you need without connecting any of them to the camera.

Even though the camera has X-sync only, certain flashbulbs can be used at specified shutter speeds as shown in the accompanying table.

Multiple Exposures—There is no "official" way to make multiple exposures with the AT-1. Here's a method that will work:

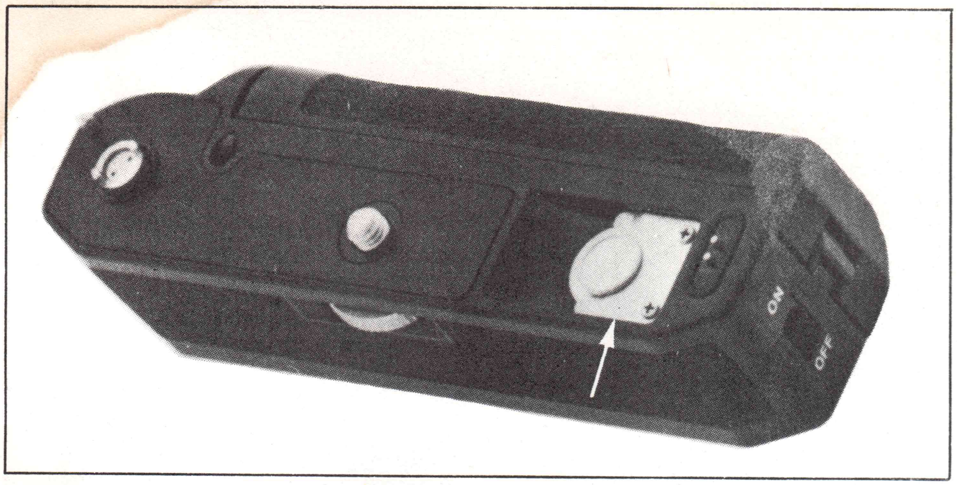
Make the first exposure. Rotate the Rewind Knob gently to remove slack in the film path. Hold the knob that way. Depress the Rewind Button on the bottom of the camera. Hold it in. Operate the Film-Advance Lever one full stroke. Release everything. Make the next exposure.

Film registration may change from shot to shot with this procedure. Also, the rewind button on the bottom of the camera may remain depressed of its own accord, forcing you to make another exposure before the film will start advancing again. If so, put the lens cap on during the additional unwanted exposure.

Because film registration may change during multiple exposures, a blank frame before and after the multiple-exposed frame is good insurance.

The frame counter will not advance when making multiple exposures.

Film Rewind Procedure—Same as all Canon cameras. Depress the Rewind Button and turn the Rewind Crank slowly in the direction of the arrow. You can feel the rewind tension change when the film end pulls out of the take-up spool. The frame counter runs backwards during the rewind procedure, counting down to 0 and then on to S. Some photographers prefer not to wind film all the way back into the cartridge. At S, it is safe to open the camera back and the film will not be wound fully into the cartridge.



Power Winder A attaches to bottom of AE-1 and AT-1, by turning screw into tripod socket on camera base. First remove Winder Coupler Cover from bottom of camera—store it in special clip on top of Winder A (arrow).

CANON POWER WINDER A SPECIFICATIONS

Winding Speed: Up to two frames per second for sequence shooting. Single-frame winding for intermittent shooting possible.

Operation: Activated by the shutter-release button.

Shutter Speed Coupling Range: 1/60 to 1/1000 sec. for AE sequence shooting. "B" or 2 sec. to 1/1000 for single-frames. No AE photography at "B."

Frame Counting: Frame counter of the camera shows the number of frames run.

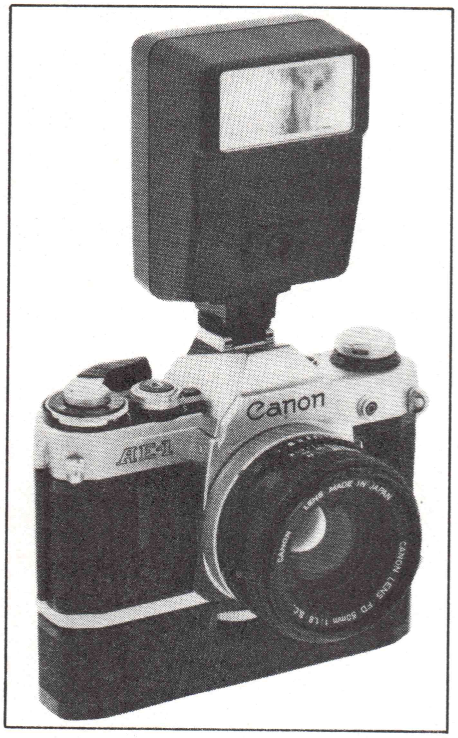
Safety Circuit: When the film is completely wound or when the battery power fails, the Power Winder A automatically stops and its LED flashes.

Power Source: Four AA size batteries (over 20 rolls of 36-exposures films under normal temperature and with fresh batteries).

Attachment: The Power Winder A fastens to the tripod screw at the bottom of the camera.

Size- 141mm W x 42mm D x 34mm H.

Accessories: Carrying case and Battery Pack A (spare).



Power Winder A fits all A-series cameras—shown here on an AE-1. Speedlite 155A, shown here, and Speedlite 199A provide automatic flash photography when used on A-series cameras.

A-SERIES ACCESSORIES

A-series cameras can use any Canon accessory that attaches to the lens or lens mount. All Canon SLR's use Canon viewfinder-mounted accessories such as diopter lenses for eyesight correction, angle finders, magnifiers and eyecups. For these and other accessories that are used generally across the line of Canon SLR's, see the Canon Equipment List in the Reference Tables at the end of this chapter.

Two small accessories are included with the A-series cameras that are not used with other cameras in the line. A spare-battery holder is packaged with the camera for attachment to the camera strap. Also included with the camera is a rubber washer, Tripod Adapter A, which you should use between camera and tripod. This allows mounting the camera snugly without overtightening the attachment screw.

POWER WINDER A

Designed exclusively for the A-series, Power Winder A is triggered by the shutter button on the camera and advances film automatically after each exposure.

When firing single shots, you can select any shutter speed other than B and use the Power Winder to advance the film. Getting a single frame is done with your trigger finger—don't hold the shutter button down too long.

When exposing frames continuously by holding the shutter button down, the frame rate is 2 per second at shutter speeds faster than 1/60. The winder takes about 0.5 second to advance the film with fresh batteries. It will wait for the shutter to open and close before it advances again, so slower shutter speeds slow down the winder.

Warning Lamp—On the back of the Power Winder body is a red LED Warning Lamp which has several functions. The winder motor turns off and the lamp glows red anytime the winder cannot complete a film advance. This can occur for several reasons.

When you have shot the last frame of film in the cartridge, the winder can't pull out another frame so the light turns on and the motor turns off. If the film jams or if the batteries become discharged, the same thing happens.

When the warning light turns on, turn the winder off until the problem is corrected.

When the LED warning lamp is indicating end-of-roll, turn off the winder. Depress the rewind button on the bottom of the finder. Use the rewind crank in the usual way.

Anytime during a roll of film, you can turn the winder off and advance film manually, leaving the winder attached to the camera bottom.

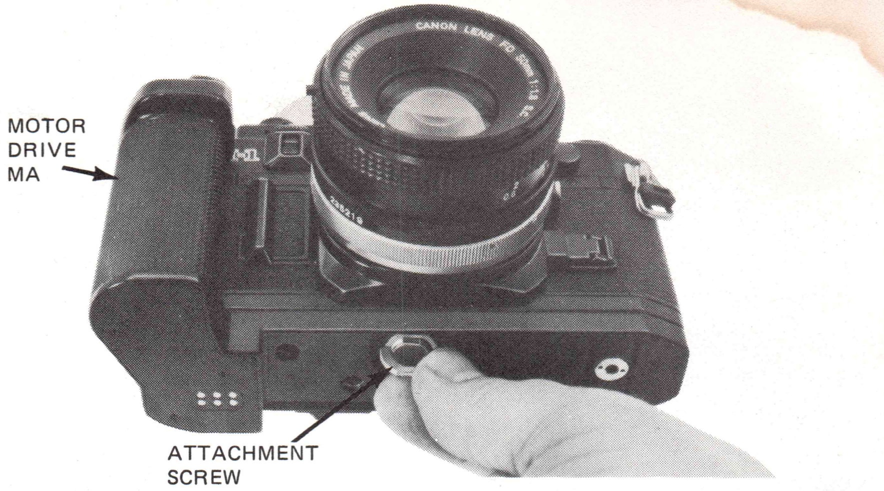
Attachment Procedure – Remove the Winder Coupler Cover from the bottom of the camera. A spring clip on the winder body holds it for you so it doesn't get lost. Place the winder against the bottom of the camera, properly oriented, and turn the Fastening Screw until snug. Battery Pack A is part of the winder, removable to replace batteries or to keep the batteries warm in cold weather. The winder should be turned off when installing it on the camera.

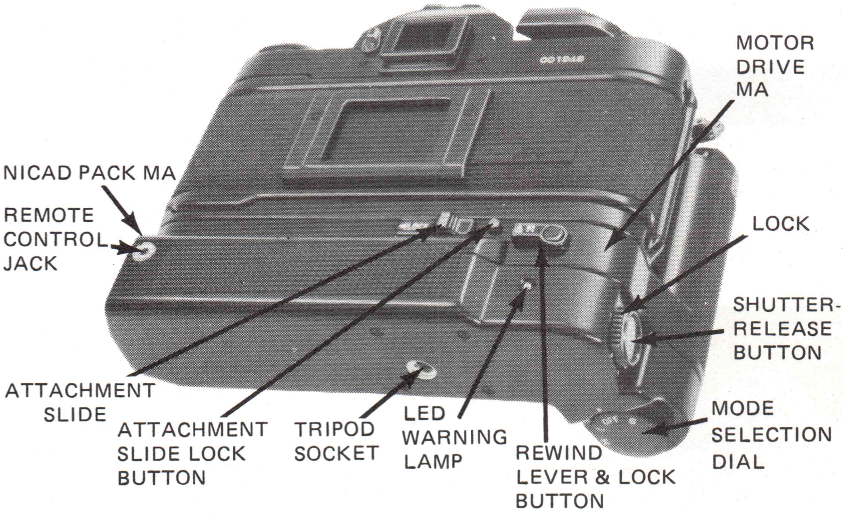
MOTOR DRIVE MA

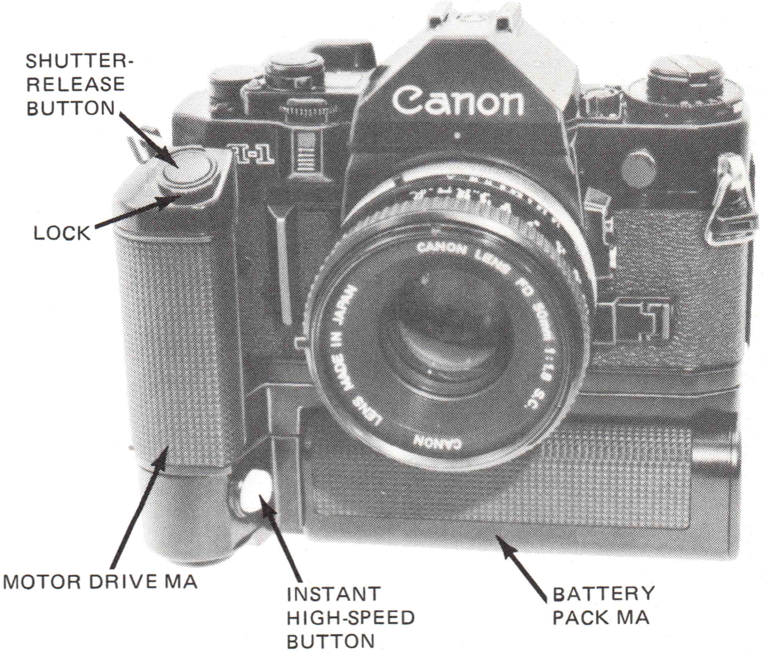
Designed for the A-1 only, this motor drive marks a new direction in design. The motor drive itself is a very small package consisting of the handle which contains the motor and a thin wafer that extends across the bottom of the camera and contains the gears. The battery case is separate.

To install the motor drive unit, first remove the Coupler Cover from the camera bottom. A holder on the motor drive gives you a place to put the cover so you don't lose it. Hold the motor drive unit on the bottom of the camera; lift the handle on the Attachment Screw and turn until the motor drive is snug against the camera.

Two battery cases are available: Battery Pack MA uses 12 AA-size


MOTOR DRIVE MA
ATTACHMENT SCREW


MOTOR DRIVE MA
NICAD PACK MA
REMOTE CONTROL JACK
LOCK
SHUTTER-RELEASE BUTTON
ATTACHMENT SLIDE
ATTACHMENT SLIDE LOCK BUTTON
TRIPOD SOCKET
LED WARNING LAMP
REWIND LEVER & LOCK BUTTON
MODE SELECTION DIAL


SHUTTER-RELEASE BUTTON
LOCK
MOTOR DRIVE MA
INSTANT HIGH-SPEED BUTTON
BATTERY PACK MA

CANON MOTOR DRIVE MA SPECIFICATIONS

Power Source: Uses either Battery Pack MA or NiCad Pack MA.

Operating Speeds: S—Single Frame; H—High; L—Low. With NiCad Pack MA, H is 4 frames per second; L is 3. With Battery Pack MA, H is 5 frames per second; L is 3.5.

Instant High-Speed: Only the Battery Pack MA has this feature. Depress the Instant High-Speed Button and the motor drive is automatically switched to maximum frame rate.

Controls: Motor drive can be operated by Shutter-Release Buttons on camera, on motor drive handle or on power pack unit. Selection of operating speed is by Mode Selection Dial on power pack.

Battery Life: Normal temperature with 36-exposure film rolls: With NiCad Pack MA, 60 rolls or more; with Battery Pack MA, 60 rolls or more. Low Temperature (—10°C): With NiCad Pack MA, 15 rolls or more; with Battery Pack MA, 5 rolls or more.

Operable Temperature Range: —10°C to +45°C.

throwaway batteries. NiCad Pack MA has a built-in rechargeable nickel-cadmium battery and comes with NiCad Charger MA which recharges the unit from a wall outlet. Incidentally, Canon literature uses *NiCd* instead of *NiCad.*

Both battery cases mount the same way: Push the battery firmly in place over the locating pins on the bottom of the motor drive unit. Depress the Attachment Slide Lock Button on the motor drive and the Attachment Slide automatically moves to the left, covering the red dot on the motor drive and simultaneously locking the battery case in place. To remove the battery, depress the button and move the slide with your finger.

With a motor drive and either of the battery cases installed, there are three shutter buttons you can use: the shutter button on the camera, the button on the top of the motor-drive handle and a button on the end of the battery case, just below the motor-drive handle. Each of these has a lock to prevent accidental operation. Only the control in use must be unlocked. Depressing any one of the buttons partway turns on the viewfinder display in the camera. Depressing it fully operates the camera shutter and the motor drive unit. Use whichever button is convenient. The button on the battery case is handy for vertical-format shots.

On the bottom of the battery case is the Mode Selection Dial which has four positions. When set to OFF, the camera behaves as if the motor drive were no longer attached. You advance film manually, using the camera film-advance lever, and expose frames using the camera shutter button. H sets the motor drive to operate at maximum speed, exposing and advancing frames continuously up to 5 per second. L is a slower operating speed but still continuous as you can see in the accompanying specifications for the motor drive. S is for single-frame operation where the motor drive advances a single frame each time you release the shutter button.

A feature of Battery Pack MA which is not on the NiCad pack is the Instant High-Speed Button. No matter which operating mode you have selected, depressing the Instant High-Speed Button causes the motor drive to operate at maximum speed. This allows you to respond to sudden changes in the action you are photographing by speeding up the motor drive using the little finger of your right hand.

On the back of each battery case is a red LED Warning Lamp. This lamp glows red and the winder motor turns off anytime the winder cannot complete a film advance. This can happen at the end of the roll, when the battery is weak or if the film jams for any reason. When the LED lamp turns on, turn the winder off until the problem is corrected.

If the LED is indicating end-of-roll, turn off the winder. Depress the Rewind Lever Lock Button and then rotate the Rewind Lever clockwise. This pushes in the rewind button on the bottom of the camera and prepares the mechanism to rewind film. Rewind and reload in the usual way, then turn the motor drive back on.

Remote Control—The Remote Control Jack allows remote control by a pushbutton on the end of an extension cord, by Interval Timer L, by Wireless Controller LC-1, or by special equipment to suit special applications. Your Canon dealer can put you in touch with a Canon Technical Representative if you need more information about remote control.

WIRELESS CONTROLLER LC-1

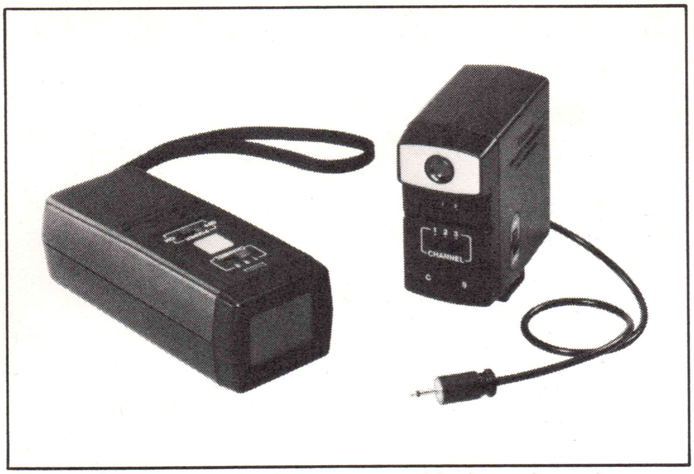
Motor Drives MA and MF can be controlled from a distance by the hand-held LC-1 Transmitter which sends an infrared control signal to an LC-1 Receiver unit mounted in the camera hot shoe for convenience and cord-connected to the Remote Control Jack on the motor drive. Using infrared requires that there be direct line-of-sight between the transmitter and receiver, but it avoids possible interference when several photographers are all using radio-controlled units in the same vicinity. To avoid interference among several LC-1 systems in the same area, each can be set to a different channel, choosing among three operating channels. More than one LC-1 Receiver can be controlled by the same transmitter, either all on the same channel or on different channels.

SPECIAL ELECTRONIC FLASH

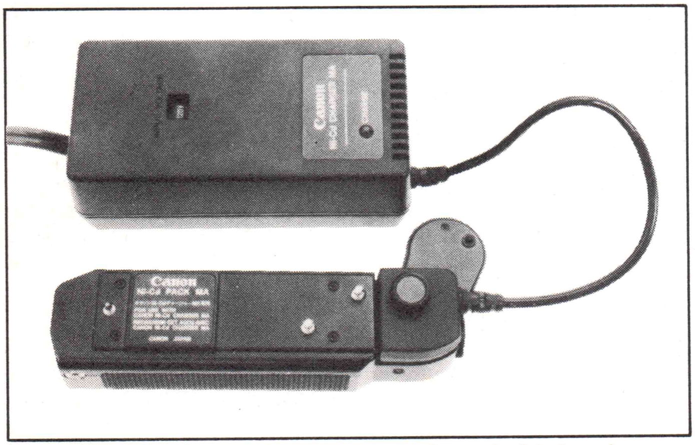
The special 155A and 199A flash units for A-series cameras are described in Chapter 16.

CANON EXTERNAL BATTERY PACK A

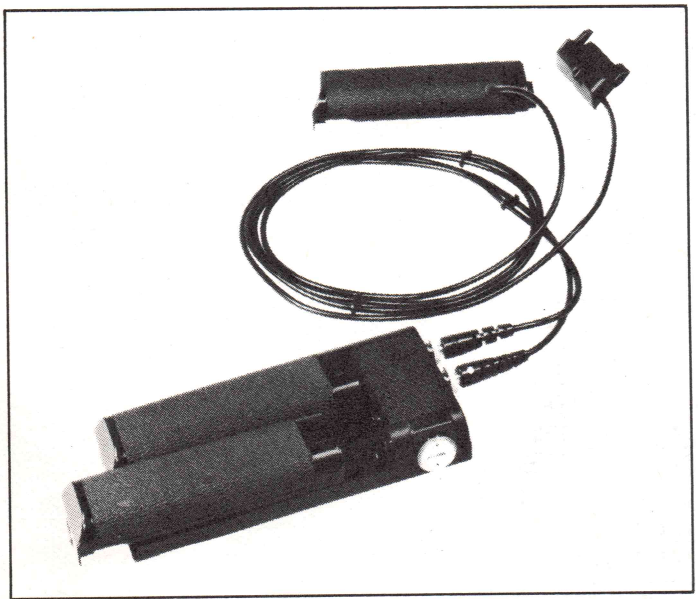
For cold weather use, a special NiCad battery pack is available. It plugs into the battery compartment of any A-series camera and also furnishes power to Power Winder A. The external battery pack connects to the camera and winder through cables so you can keep the external batteries warm by carrying them in your pocket.



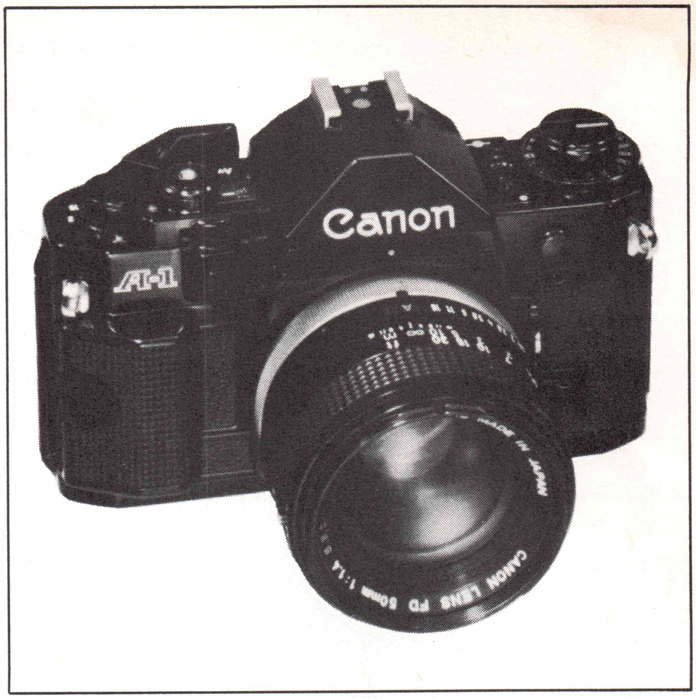
Wireless Controller LC-1 is compact, with three-channel versatility.



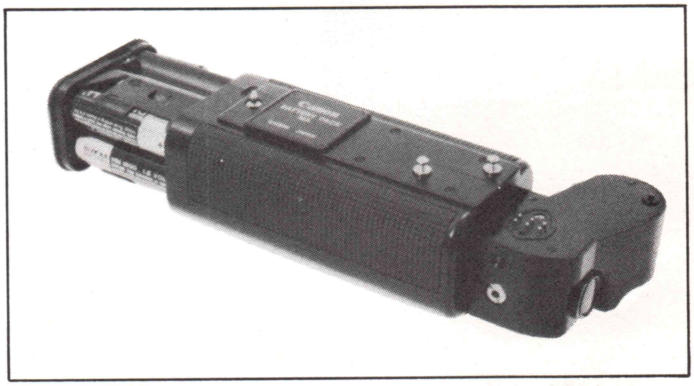
NiCad (Ni-Cd) Charger MA operates on household electric current to recharge NiCad Battery Pack MA.



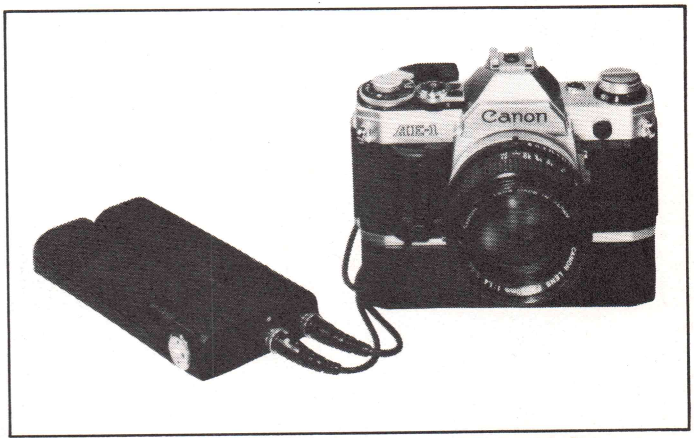
Canon External Battery Pack A supplies power for an A-series camera body and Power Winder A. In cold weather, you can maintain battery efficiency by keeping battery case in your pocket so it stays warm.



Action Grip attaches to camera body below A-1 symbol. This grip and motor drive cannot be used simultaneously.



Battery Pack MA, for Motor Drive MA, uses eight AA-size batteries in a slide-in battery holder.



External Battery Pack A connected to an AE-1 with Power Winder A.

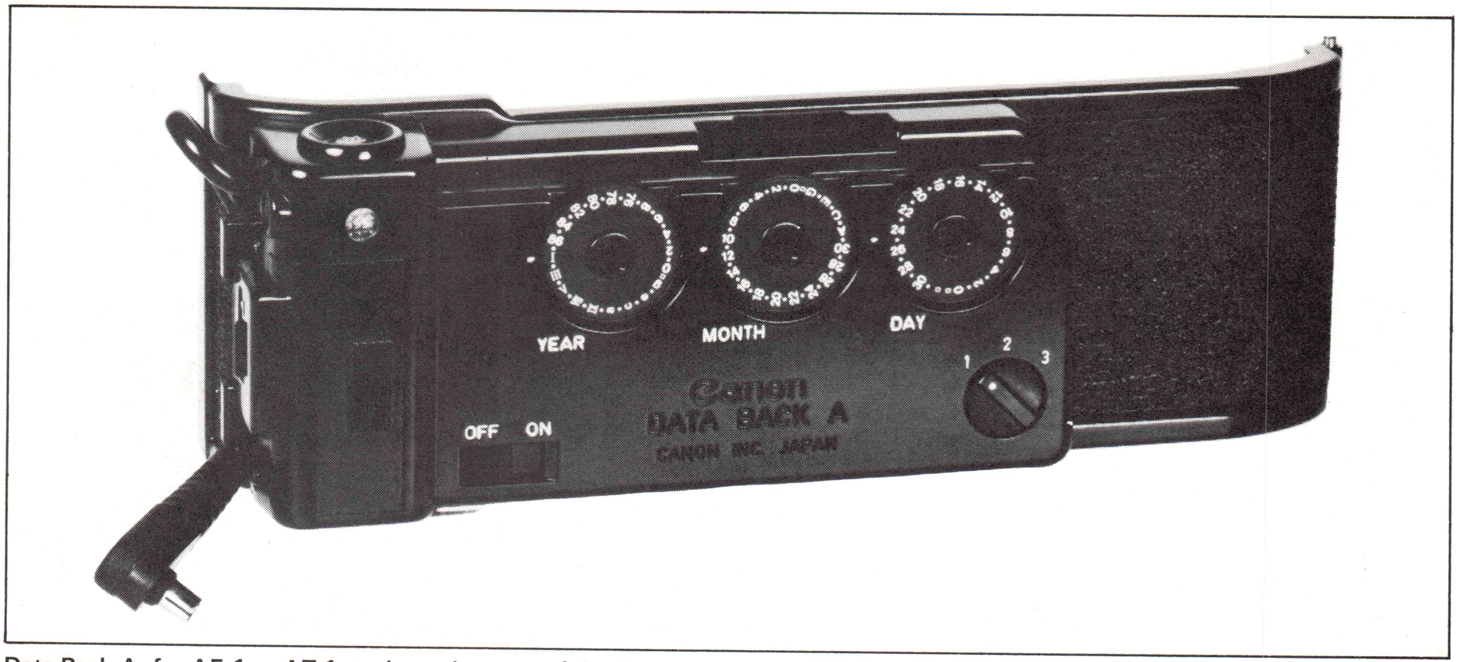
A-SERIES ACCESSORIES

DATA BACK A

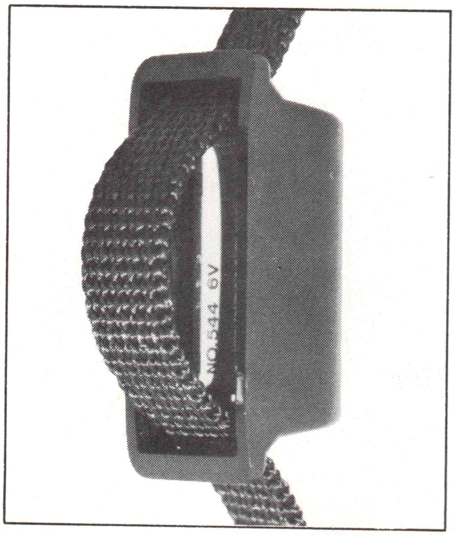
The Data Back replaces the back cover of A-series cameras, removed by sliding the hinge pin downward. The Data Back exposes letters and numbers onto the film in the lower right corner of the frame. Data to be recorded is selected by rotating three dials marked YEAR, MONTH, and DAY. They can be used for dating the frame, but the dials also have letters and other symbols as shown in the specifications, so other kinds of data can be encoded using the available symbols.

Exposure is made by a battery-powered lamp in the data back, triggered by a cord connection to the flash socket on the camera. This exposes each frame as the camera is operated—either manually or with Power Winder A at 2 frames per second. A red lamp on the Data Back flashes each time data settings are exposed onto film.

Data printing can be controlled manually, using a pushbutton on the data back. Thus you can print data on some frames, but not all, as you choose. The film emulsion is exposed from the back, through the film base. Switches on the data back set up the unit to give proper exposure depending on the type of film being used.



Data Back A, for AE-1 or AT-1, replaces the camera's back cover.



If the battery fails, you cannot operate an A-series camera. You will be shooting again with only a short delay if you carry a spare in the spare-battery holder.

CANON DATA BACK A SPECIFICATIONS

Attachment: To camera back after removal of the back cover.
Data Setting: Done by three rotating dials.
Right Dial: 32 figures and blank (0 to 31 and □).
Center Dial: 39 figures and blank (0 to 31, A to G and □).
Left Dial: 39 figures and blank (0 to 9, 76 to 87, Roman numerals I to X, a to g, and □).
Data Imprinting: By special synchronization cord and built-in lamp. Manual imprinting of the data with the manual imprint button.
Exposure Adjustment: Three different positions. Black and white and 2 color positions.
Color 1: ASA 64 to 160 color films.
Color 2: ASA 25 to 10 color films.
Indicator Lamp: LED lamp indicates data imprinting.
Power Source: One 6V silver oxide battery #544; good for 10,000 flashes or one year use.
Size: 145mm W x 33mm D x 54mm H.
Weight: 110 g (including battery)
Accessories: Special synchronization cord and case.

THE EF CAMERA

The EF is designed basically as an *automatic* camera to use the FD lens series. It is a shutter-preferred camera with central-emphasis metering.

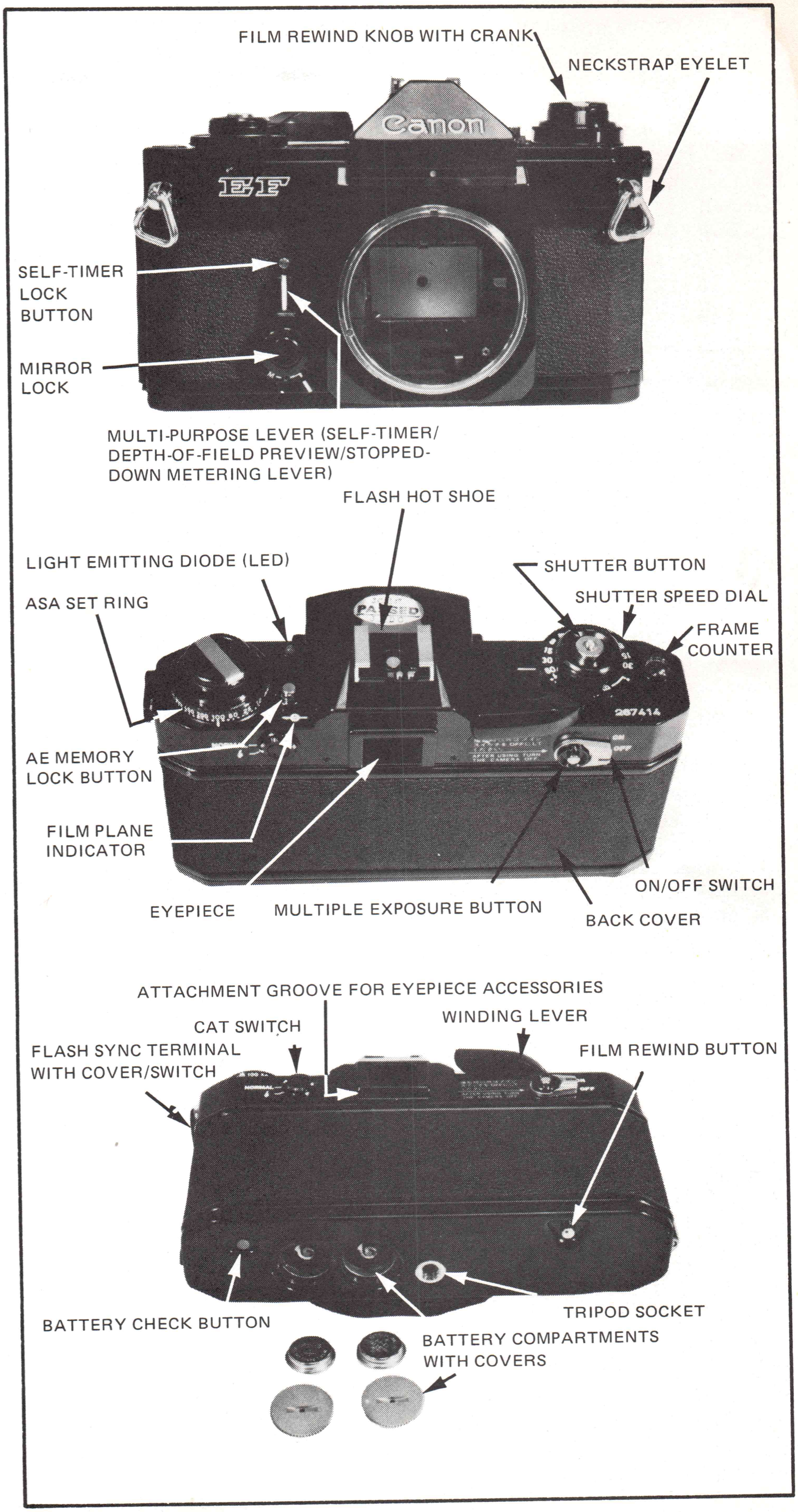
The basic control which puts the EF into automatic operation is the aperture ring on an FD lens. Set it to the green circle or letter A and the camera is set up to control aperture size automatically.

The ON-OFF switch on the back of the camera turns on the camera electronics including metering and the shutter electronic-timer circuit used for shutter speeds from 1 second to 30 seconds. Shutter speeds faster than that are mechanically timed, and can be used even with dead batteries.

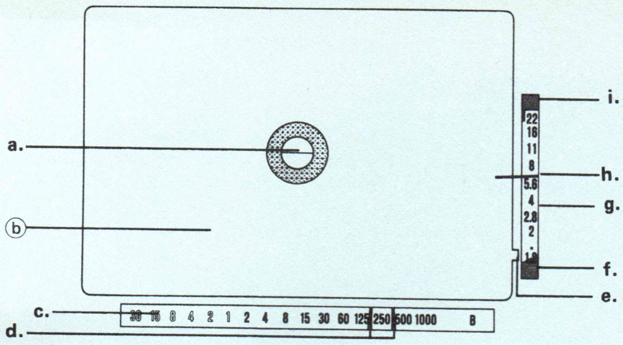
It's a good idea to always carry two spare batteries. With the camera, Canon supplies a small case for spare batteries which can be attached to the camera strap.

The CAT switch has two positions: NORMAL, and an arrow signifying "flash." For use with the CAT flash unit, this switch should be rotated to the flash arrow position. With all other flash units, the switch is left in the NORMAL position. When the CAT flash unit is installed on the camera, it can be completely disconnected without physically removing the flash unit simply by rotating the CAT switch to the NORMAL setting. Then the camera can be used in the regular way. When you remove the CAT flash unit from the camera, you *must* turn the CAT switch back to NORMAL or the camera will be inoperative.

Flash units not equipped with a hot-shoe contact have a PC-cord connector which plugs into a PC connector on the camera body. A sliding cover over this connector is also a switch which disconnects the hot-shoe contacts from the flash-firing circuit. You cannot fire two flashes simultaneously—one in the hot shoe and the other connected to the PC outlet.


FILM REWIND KNOB WITH CRANK
NECKSTRAP EYELET
Canon
EF
SELF-TIMER LOCK BUTTON
MIRROR LOCK
MULTI-PURPOSE LEVER (SELF-TIMER/DEPTH-OF-FIELD PREVIEW/STOPPED-DOWN METERING LEVER)
FLASH HOT SHOE
LIGHT EMITTING DIODE (LED)
SHUTTER BUTTON
ASA SET RING
SHUTTER SPEED DIAL
FRAME COUNTER
AE MEMORY LOCK BUTTON
FILM PLANE INDICATOR
ON/OFF SWITCH
EYEPIECE
MULTIPLE EXPOSURE BUTTON
BACK COVER
ATTACHMENT GROOVE FOR EYEPIECE ACCESSORIES
CAT SWITCH
WINDING LEVER
FLASH SYNC TERMINAL WITH COVER/SWITCH
FILM REWIND BUTTON
TRIPOD SOCKET
BATTERY CHECK BUTTON
BATTERY COMPARTMENTS WITH COVERS

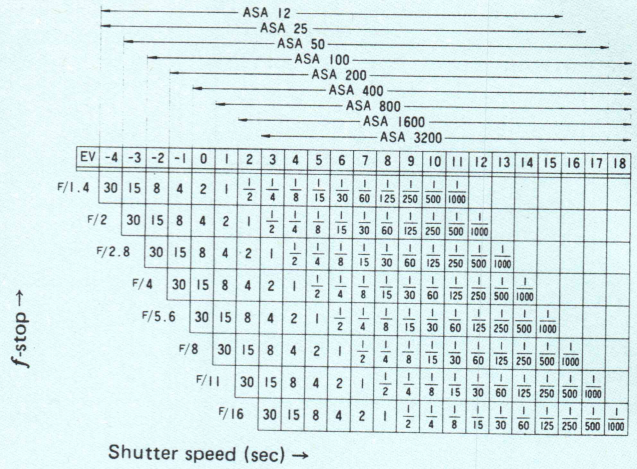
EF VIEWFINDER INFORMATION



a. Center Split-Image/Microprism Rangefinder
b. Ground Glass with Fresnel Screen
c. Shutter Speed Scale
d. Shutter Speed Indicator
e. Stopped-Down Metering Index Mark
f. Underexposure Warning Mark (maximum lens aperture is automatically set)
g. Aperture Scale
h. Meter Needle
i. Overexposure Warning Mark

AUTOMATIC EXPOSURE RANGE OF PHOTOCELL OF EF CAMERA AT VARIOUS FILM SPEEDS

(FD 50mm *f*-1.4 S.S.C. LENS



EV	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
F/1.4	30	15	8	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000							
F/2		30	15	8	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000						
F/2.8			30	15	8	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000					
F/4				30	15	8	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000				
F/5.6					30	15	8	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000			
F/8						30	15	8	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000		
F/11							30	15	8	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	
F/16								30	15	8	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000

Shutter speed (sec) →

The viewfinder display shows the selected shutter speed on a scale along the bottom. A moving needle along the right side shows the aperture that will be used automatically when the shutter button is depressed. The scale on the right side is *f*-numbers and is automatically changed to show the same *f*-number range as the lens you have on the camera. Over- and underexposure is indicated by red bands at the top and bottom of the *f*-number scale.

When you have focused and are ready to shoot, you can see *both* shutter speed and the *f*-stop that will be used. If they are satisfactory for your purpose, depress the shutter button and aperture will be locked at the *f*-stop indicated by the display just at the instant you pushed the shutter release. Exposure will be made at that aperture.

If you are shooting a non-average scene and don't want to use the aperture indicated by the display, there are three ways to take control. One is to change the film-speed dial to a higher or lower number. The camera will "re-figure" exposure based on the new film-speed setting and you have made the correction.

Another way to override the automatic exposure is to use the EE Memory Lock button. When this button is depressed, the camera exposure mechanism locks aperture at whatever the meter is reading, just as it normally does when you depress the shutter button.

The third way to override automatic exposure is to observe what the camera "plans" to do, put the camera on manual operation and use any aperture you choose.

Using the EF on manual is not as convenient as a match-needle camera because the viewfinder display continues to operate as an automatic camera. It will show the aperture the camera *would* use if it were on automatic, but won't actually set the lens. You can observe the display, noticing the *f*-number it recommends, then set that *f*-number onto the lens before shooting and you will get normal exposure. The only guarantee that the lens aperture is set is *you.*

The EF is designed as an automatic camera using FD lenses with full-aperture metering. Stopped-down metering is not recommended with FD lenses and may not be accurate. The exception is use of non-meter-coupled accessories between an FD lens and the camera. You have to use stopped-down metering, matching the moving needle to a notch near the bottom of the *f*-number scale.

When using FL lenses on an EF camera, stopped-down metering must be used and is normally satisfactory.

EF FLASH SYNCHRONIZATION

TYPE	SHUTTER SPEED
CAT Automatic	1/125
Canon Speedlite (Non-Automatic)	1/125 or slower
Other Electronic Flash	1/125 or slower
Flashbulbs: M, MF and FP	1/15 or slower

During long timed exposures from 1 to 30 seconds you may wonder if the camera is still working. It reassures you by blinking a small red Light-Emitting Diode (LED) just in front of the Memory Lock button. The LED also serves as a very handy battery check. Push the small red button on the bottom of the camera and the LED should blink rapidly. If it blinks sluggishly or not at all, replace the batteries.

When the EF is on automatic, operating the Stopped-Down Lever to see depth of field doesn't work—the lens stops down to minimum aperture every time. The reason is the FD lens mechanism as explained in Chapter 10.

You *can* see depth of field at the shooting aperture, but you have to work a little. Take the camera off automatic, set the shooting aperture at the lens, then operate the Stopped-Down Lever.

Double Exposure—Double and multiple exposures are a cinch with the EF. In the center of the ON-OFF switch is a button which, when depressed, allows you to operate the film-advance lever without advancing the film. This winds up the camera mechanism so you can expose the same frame repeatedly.

The frame counter of the EF counts actual frames of film rather than the number of times the film-advance lever is operated.

Using The EF With Lenses Having Minimum Apertures Smaller Than *f*-22—The EF was designed to show apertures down to *f*-16 or *f*-22 by the moving needle in the viewfinder display. The *f*-number scale in the display changes automatically to display the same range of *f*-stops as the lens in use—*in most cases.*

When a lens with a working aperture of *f*-32 is used with an EF on automatic, the display may give a false overexposure indication. Here's why: As light increases, the EF will automatically select smaller and smaller lens openings until it reaches *f*-22. If the light is still brighter, the camera mechanism will assume that the lens cannot be stopped down below *f*-22, so the needle moves to the next position on the scale—overexposure. With a lens which can be set to *f*-32, the camera will actually set it there and exposure may be satisfactory.

EF SPECIFICATIONS

Type: 35mm single-lens reflex AE (Automatic-Exposure) camera with focal-plane shutter, quick-return mirror and Canon Breech-Lock lens mount.
Standard Lenses: Canon FD 55mm *f*-1.2 S.S.C., Canon FD 50mm *f*-1.4 S.S.C., Canon FD 50mm *f*-1.8 S.C.
Interchangeable Lenses: FD series for AE photography or full-aperture metering with automatic diaphragm operation. FL series: Stopped-down metering with automatic diaphragm operation. R series: Stopped-down metering with manual diaphragm operation.
Viewfinder: Fixed eye-level pentaprism. Standard eyepiece is –1 diopter.
Viewfinder Information: Aperture scale with meter needle, stopped-down-metering index mark, shutter-speed scale and indicator, depth-of-field preview, over and underexposure warning marks.
Viewfinder Attachments: Angle finders, magnifiers, eyecup and 10 Dioptric Adjustment Lenses from -4 to +3 diopters.
Focusing Screen: Similar to Screen E, page 149: Center split-image/microprism surrounded by matte screen with Fresnel lens.
Field of View: 92% vertical and 93% horizontal coverage of actual picture area. 0.82x magnification with 50mm lens at infinity.
Mirror: Quick-return type, can be locked in up position.
Shutter: Metal focal plane, vertical movement. Mechanically controlled from 1/2 sec. to 1/1000 sec. and B in 11 steps. Electronically controlled from 30 sec. to 1 sec. in 6 steps.
Shutter-Speed Dial:

B, 1–1/1000 sec.	white marking
1/125 sec. (X sync.)	orange marking
30–2 sec.	yellow marking

Slow-Shutter-Speed Indicator: Light-Emitting Diode (LED) flashes when shutter speeds from 30 sec. to 1 sec. are used.
Self-Timer: Built-in. Multi-Purpose Lever sets approx. 10 sec. time delay for shutter. Activated by shutter release.
Film-Speed Range: ASA 12–3200.
Exposure Adjustment & Meter: Shutter-preferred AE (Automatic Exposure) photography with FD lenses. Aperture adjusted automatically after ASA and shutter speed are set. On manual setting, meter indicates required aperture and you must set aperture manually. Silicon photocell used with central-emphasis metering system.
AE Memory Lock: *f*-stop set by AE control can be locked-in by pressing the AE Memory Lock button.
Exposure-Meter-Coupling Range: With ASA 100 film, EV–2 to EV 18 (*f*-1.4 at 8 sec. to *f*-16 at 1/1000 sec.) With ASA 25 film, EV–4 to EV 16 (*f*-1.4 at 30 sec. to *f*-8 at 1/1000 sec.).
Batteries: Two 1.3V M20 (625) batteries.
Flash Synchronization: X (electronic flash) sync at 1/125 sec. and slower. FP, M, MF flashbulbs sync at 1/15 sec. and slower.
Flash Connections: Hot shoe has two contacts for Canon Auto Tuning (CAT) System. Hot shoe also has contacts for conventional electronic-flash units.
Canon Auto Tuning (CAT) System: Uses Flash Auto-Ring A2 or B2 and Speedlite 133D with FD 50mm *f*-1.4 S.S.C., FD 50mm *f*-1.8 S.C., FD 35mm *f*-3.5 S.C. or FD 35mm *f*-2 S.S.C. lenses. ASA, focused distance and recharge-level signal automatically adjust aperture to *f*-stop indicated in viewfinder.
Depth-of-Field Preview: Wind film, manually set aperture, press Multi-Purpose Lever.
Film Loading: Uses multi-slot take-up spool. Accepts any standard 35mm film roll in cartridge.
Film-Advance Lever: Single stroke, 120° throw. Lever moves to 15° stand-off position when camera is turned on.
Film Rewind: Uses rewind button and crank.
Frame Counter: S-1-38, counts every full stroke of film-advance lever, except when Multiple-Exposure button is pressed. Automatically resets to S when back cover is opened.
Multiple Exposures: Requires pressing Multiple Exposure button while operating film-advance lever. Any number of exposures can be made on same frame by repeating procedure. Frame counter stops during multiple exposures.
Dimensions: Body only: 151 x 96 x 48mm (5-15/16" x 3-3/4" x 1-7/8"). With *f*-1.4 lens: 151 x 96 x 100mm (5-15/16" x 3-3/4" x 3-15/16").
Weight: Body only: 740g (1.63 lbs.). With *f*-1.4 lens: 1,045g (2.31 lbs.).
Specifications subject to change without notice.

FTb

THE FTb CAMERA

The FTb is a simplified and less expensive F-1. It is a match-needle camera with semi-spot metering. A booster accessory is available for low light, but it cannot use a motor drive. The pentaprism is not removable.

In 1974, Canon added a shutter-speed indicator to the viewfinder display and a switch-cover for the PC connector. Canon did not change the model designation of the camera, but dealers and customers did, referring to it as the New FTb. Some dealer ads list it as the FTbN with the "N" signifying "new."

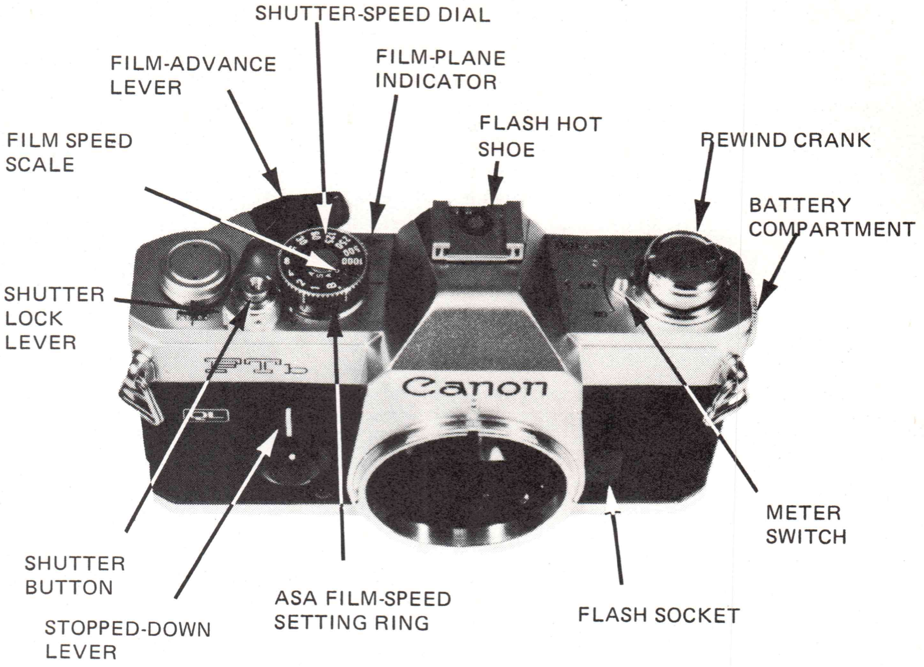
The FTb uses the Quick Load (QL) takeup spool which automatically grabs the end of the film after you close the camera back.

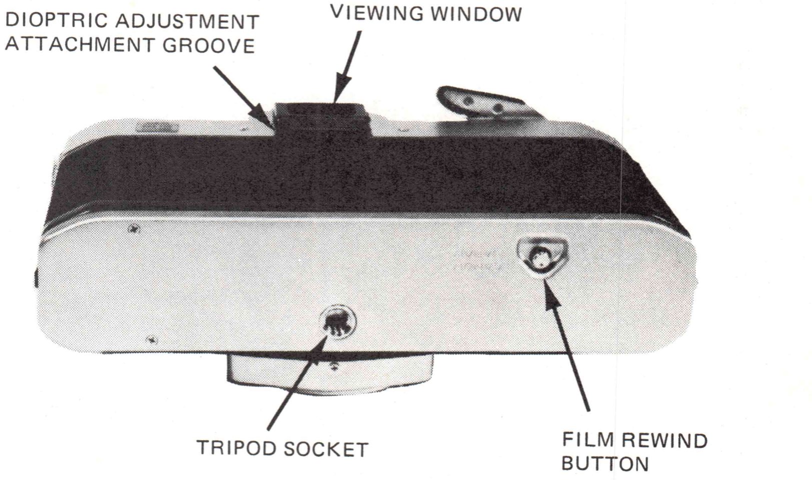
It uses all lenses and lens accessories, meters wide-open or stopped down, shows depth of field by the Stopped-Down Lever, has a self-timer and hot shoe adapted for the CAT flash, uses any other electronic flash and some flash bulbs, and has a horizontal focal-plane shutter made of cloth with a top speed of 1/1,000. The camera has a connector in the battery case for use of the Canon Booster in low-light situations.

Double exposures are made by a fairly complicated procedure involving partially rewinding the film—similar to the early F-1 models. The procedure is described in the instruction booklet and works if you follow it exactly.

An "unofficial" way that usually works is as follows:

Make exposure #1. Rotate rewind knob to remove slack in film path. Hold knob that way. Depress rewind button on camera bottom. Hold it down. Operate film-advance lever one full stroke. Release everything. Make next exposure. Film registration may change from shot to shot with this procedure. Leave the following frame blank as a precaution—shoot it with the lens cap on.


SHUTTER-SPEED DIAL
FILM-ADVANCE LEVER
FILM-PLANE INDICATOR
FLASH HOT SHOE
FILM SPEED SCALE
REWIND CRANK
BATTERY COMPARTMENT
SHUTTER LOCK LEVER
FTb
QL
Canon
METER SWITCH
SHUTTER BUTTON
ASA FILM-SPEED SETTING RING
FLASH SOCKET
STOPPED-DOWN LEVER

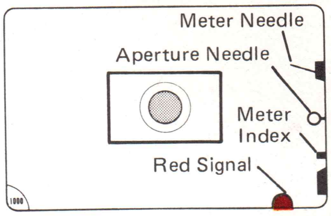

DIOPTRIC ADJUSTMENT ATTACHMENT GROOVE
VIEWING WINDOW
TRIPOD SOCKET
FILM REWIND BUTTON

FTb SPECIFICATIONS

Type: 35mm single-lens reflex with focal-plane shutter, quick-return mirror and Canon Breech-Lock lens mount.
Standard Lenses: Canon FD 55mm ƒ-1.2 S.S.C., Canon FD 50mm ƒ-1.4 S.S.C., Canon FD 50mm ƒ-1.8 S.C.
Interchangeable Lenses: Canon FD series: Full-aperture metering with automatic diaphragm operation. FL series: Stopped-down metering with automatic diaphragm operation. R series: Stopped-down metering with manual diaphragm operation.
Viewfinder: Fixed eye-level pentaprism. Standard eyepiece is −1.2 diopter.
Viewfinder Information: Meter and aperture needles, shutter-speed indicator, red signal indicates when outside of meter-coupling range, meter index for stopped-down metering and battery check, coupling-range-limit marks, depth-of-field preview, over and underexposure warning marks.
Viewfinder Attachments: Angle Finders A2 and B, Magnifier S, 10 Dioptric Adjustment Lenses from -4 to +3 diopters.
Focusing Screen: Similar to Screen A, page 149: Center microprism focusing aid surrounded by matte screen with Fresnel lens. Uses metering beam-splitting condenser.
Field of View: 94% of actual picture area. 0.85x magnification with standard 50mm lens at infinity.
Mirror: Quick-return type, can be locked in up position.
Shutter: Cloth focal plane, horizontal movement. Speeds 1 sec. to 1/1000 and B. X contact at 1/60. Shutter-release button can be locked.
Self-Timer: Built-in. Stopped-Down Lever sets approx. 10 sec. time delay for shutter. Activated by shutter release.
Film-Speed Range: ASA 25–2000.
Exposure Meter: Built-in match-needle type for full-aperture metering with FD lenses. Coupled to shutter speeds, film speeds and ƒ-stops. CdS photocell provides semi-spot metering of central 12% of picture area. Stopped-down metering is done with Meter Index and lockable Stopped-Down Lever.
Exposure-Meter Coupling Range: With ASA 100 film, EV 2.5 to EV 18 (ƒ-1.2 at 1/4 sec. to ƒ-16 at 1/1000 sec.).
Low-Light Metering: With Canon Booster and ASA 100 film, EV −3.5 to EV 10 (ƒ-1.2 at 15 sec. to ƒ-22 at 1/2 sec.).
Battery: One 1.3V M20 (625) battery.
Flash Synchronization: FP and X contacts. X (electronic flash) sync at 1/60 sec. and slower. FP flashbulb sync at 1/125–1/1000 sec. and 1/30 sec. and slower. M, MF flashbulb sync at 1/30 sec. and slower.
Flash Connections: Hot shoe has two contacts for Canon Auto Tuning (CAT) System. Hot shoe also has contacts for conventional electronic-flash units. PC socket on front of body.
Canon Auto Tuning (CAT) System: Uses Flash Auto-Ring A2 or B2 and Speedlite 133D with FD 50mm ƒ-1.4 S.S.C., FD 50mm ƒ-1.8 S.C., FD 35mm ƒ-3.5 S.C. or FD 35mm ƒ-2 S.S.C. lenses.
Film Loading: QL mechanism for quick loading of film. Accepts any standard 35mm film roll in cartridge.
Film-Advance Lever: Single or multiple-stroke, 174° throw. 15° Standoff.
Film Rewind: Uses rewind button and crank.
Frame Counter: Counts every full stroke of film-advance lever from S-1-38, including those for multiple exposures. Resets to S when back cover is opened.
Multiple Exposures: Use procedure detailed on page 163.
Dimensions: Body only: 144 x 93 x 43mm (5-5/8" x 3-5/8" x 1-3/4").
Weight: Body only: 750g (1.66 lbs.).

Specifications subject to change without notice.

FTb VIEWFINDER DISPLAY



ASA	25	•	•	50	•	•	100	•
		(32)	(40)		(64)	(80)		(125)
	•	200	•	•	400	•	•	
	(160)		(250)	(320)		(500)	(650)	
	800	•	•	1600	•			
		(1000)	(1250)		(2000)			

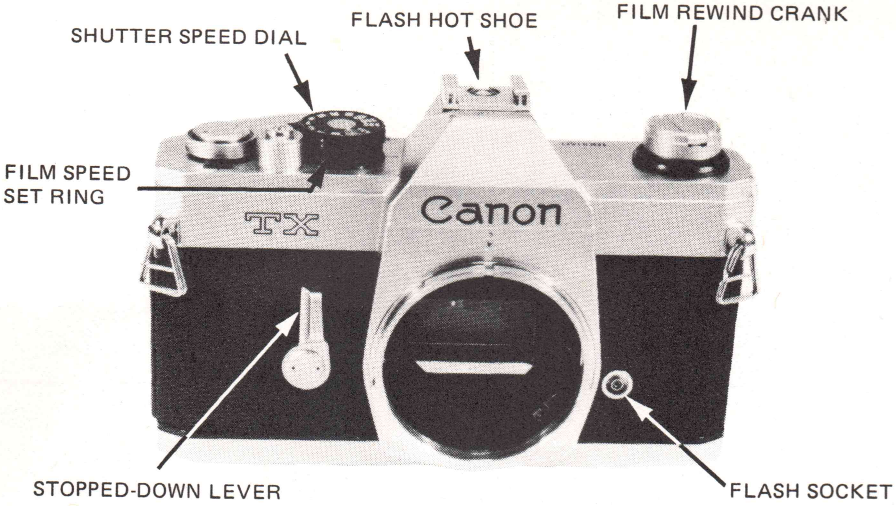
There isn't enough room on the film-speed dial to show all settings. Figures in parentheses appear as dots on the dial.

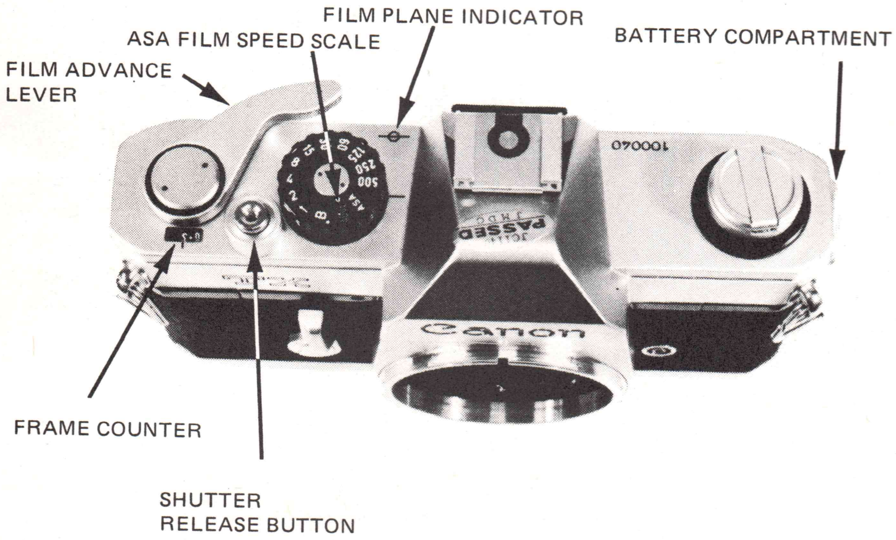
FTb COUPLING RANGE OF BUILT-IN EXPOSURE METER

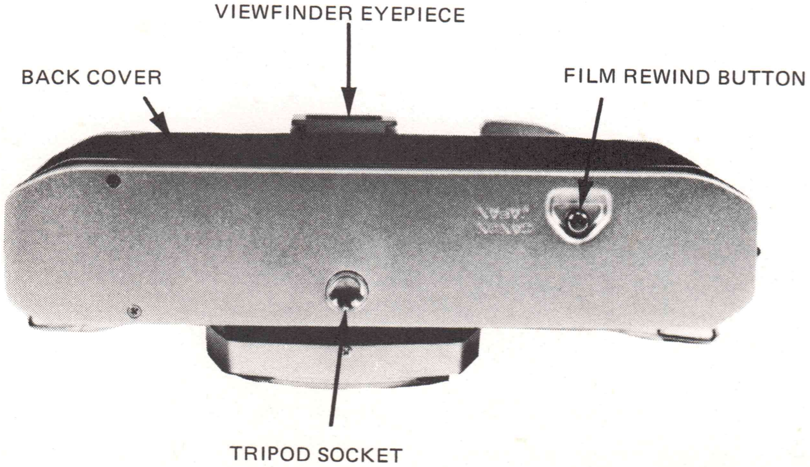
Film Speed	Shutter Speed										
ASA 25	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000
ASA 50	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	…
ASA 100	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	…	…
ASA 200	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	…	…	…
ASA 400	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	…	…	…	…
ASA 800	1/30	1/60	1/125	1/250	1/500	1/1000	…	…	…	…	…
ASA 1600	1/60	1/125	1/250	1/500	1/1000	…	…	…	…	…	…
Minimum f/stop	f/22	f/22	f/22	f/22	f/22	f/22	f/22	f/22	f/16	f/11	f/8

FTb FLASH SYNCHRONIZATION

TYPE		SHUTTER SPEED
CAT Automatic		1/60
Canon Speedlite (Non-automatic)		1/60 or slower
Other Electronic Flash		1/60 or slower
Flashbulbs:	FP	1/125 or faster, and 1/30 or slower
	M	1/30 or slower
	MF	1/30 or slower


SHUTTER SPEED DIAL
FLASH HOT SHOE
FILM REWIND CRANK
FILM SPEED SET RING
Canon
TX
STOPPED-DOWN LEVER
FLASH SOCKET


FILM PLANE INDICATOR
ASA FILM SPEED SCALE
BATTERY COMPARTMENT
FILM ADVANCE LEVER
Canon
FRAME COUNTER
SHUTTER RELEASE BUTTON


VIEWFINDER EYEPIECE
BACK COVER
FILM REWIND BUTTON
TRIPOD SOCKET

THE TX AND TLb CAMERAS

These are simplified versions of the FTb. In 1975 the TLb was replaced by the TX. The main difference is addition of a hot shoe in the TX model. This hot shoe has a contact to fire flash units but does not have the additional contracts to use the CAT flash.

The TX has a cloth focal-plane shutter which operates horizontally with a top speed of 1/500. Metering is by a cadmium-sulfide cell placed above the viewfinder window to read the entire viewing screen with Central Emphasis. No booster is available. All lenses and lens accessories can be used. Metering is wide-open with FD lenses and stopped-down with FL lenses.

The Stopped-Down Lever closes lens aperture for stopped-down metering or viewing depth of field, but has no other functions. It cannot be locked in the stopped-down position, but FD lenses can be set for manual control of aperture in the usual way—by moving the Automatic-Manual lever on the back of the lens fully counterclockwise. There is no capability for mirror lockup and no self-timer.

Within its capability limits, pictures made with a TX or TLb should be as good as with any other Canon SLR. Picture quality depends mainly on the lens, film flatness and film location in the camera. All current Canon SLR's use the same lenses and all have excellent film guiding and film flatness.

Multiple-exposure procedure is the same as for the FTb, page 182.

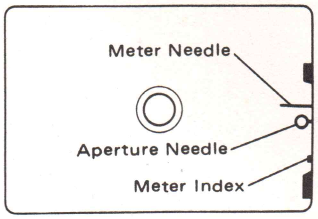
For the person who wants a relatively inexpensive SLR, who is not much interested in the technical aspects and "gadgets" of photography, and who mainly wants high-quality pictures of ordinary things such as portraits and scenery, the TX is a good choice.

TX SPECIFICATIONS

Type: 35mm single-lens reflex with focal-plane shutter, quick-return mirror and Canon Breech-Lock Lens mount.
Standard Lens: Canon FD 50mm *f*-1.8 S.C.
Interchangeable Lenses: Canon FD series: Full-aperture metering with automatic diaphragm operation. FL series: Stopped-down metering with automatic diaphragm operation. R series: Stopped-down metering with manual diaphragm operation.
Viewfinder: Fixed eye-level pentaprism. Standard eyepiece is −1.2 diopter.
Viewfinder Information: Meter needle and aperture needle, red signal indicating outside of meter-coupling range, meter index for stopped-down metering, depth-of-field preview, over and underexposure warning marks.
Viewfinder Attachments: Angle Finder A2, B, Magnifier S, 10 Rectangular Dioptric Adjustment Lenses from -4 to +3 diopters.
Focusing Screen: Similar to Screen A, page 149: Center microprism surrounded by matte screen with Fresnel lens.
Field of View: 94% of actual picture area. 0.85x magnification with standard 50mm lens at infinity.
Shutter: Cloth focal plane, horizontal movement. Speeds 1 sec. to 1/500 and B. X contact at 1/60 sec.
Film-Speed Range: ASA 25–2000.
Exposure Meter: Built-in match-needle type for full-aperture metering with FD lenses. Coupled to shutter speeds, film speeds and *f*-stops. Stopped-down metering with Stopped-Down Lever and Meter Index. CdS photocell behind pentaprism used with central-emphasis metering.
Exposure-Meter-Coupling Range: With ASA 100 film, EV 3.7 to EV 17 (*f*-1.8 at 1/4 sec. to *f*-16 at 1/500 sec.).
Battery: One 1.3V M20 (625) mercury battery.
Flash Synchronization: FP and X contacts. X (electronic flash) sync at 1/60 sec. and slower. FP flashbulb sync at 1/125–1/500 sec. M, MF flashbulbs sync at 1/30 sec. or slower.
Flash Connections: Flash contacts in hot shoe and in PC socket on front of body.
Multiple Exposures: Use procedure for FTb.
Film Loading: Uses multi-slot take-up spool. Accepts any standard 35mm film roll in cartridge.
Film-Advance Lever: Single or multiple-stroke, 174° throw.
Film Rewind: Uses rewind button and crank.
Frame Counter: Counts every full stroke of film-advance lever from S-1-38, including those for multiple exposures. Automatically resets to S when back cover is opened.
Dimensions: Body only: 144 x 93 x 43mm (5-5/8" x 3-5/8" x 1-3/4").
Weight: Body only: 680g (1 lb. 8 oz.).

Specifications subject to change without notice.

TX VIEWFINDER DISPLAY



TX FLASH SYNCHRONIZATION

TYPE	SHUTTER SPEED
Electronic Flash	1/60 or slower
Flashbulbs:	
FP	1/125 or faster and 1/30 or slower
M	1/30 or slower
MF	1/30 or slower

TX and TLb are similar. Neither can use CAT flash. Both can use ordinary electronic flash. TX has hot shoe to fire flash. TLb has shoe mount without electrical contacts, so flash must be cord-connected to camera body.

ASA 25 • • 50 • • 100 • • 200 • • 400 • • 800 • • 1600 •
(32) (40) (64) (80) (125) (160) (250) (320) (500) (650) (1000) (1250) (2000)

There isn't enough room on the film-speed dial to show all settings. Figures in parentheses appear as dots on the dial.

TX COUPLING RANGE OF BUILT-IN EXPOSURE METER

Film Speed	Shutter Speed									
ASA 25	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500
ASA 50	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	...
ASA 100	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	...	...
ASA 200	1/8	1/15	1/30	1/60	1/125	1/250	1/500	...	...	...
ASA 400	1/15	1/30	1/60	1/125	1/250	1/500	...	...	...	...
ASA 800	1/30	1/60	1/125	1/250	1/500	...	...	...	...	...
ASA 1600	1/60	1/125	1/250	1/500	...	...	...	...	...	...
Minimum f/stop	f/22	f/22	f/22	f/22	f/22	f/22	f/22	f/22	f/22	f/16

LENS HARD CASES

HARD CASE	LENSES			
Lens Case C	FD 24mm *f*-2.8 S.S.C. FD 35mm *f*-2 S.S.C. FL 35mm *f*-3.5 FLM 100mm *f*-4	FD 28mm *f*-3.5 S.C. FD 50mm *f*-1.8 S.C. FL 35mm *f*-2.5	FD 28mm *f*-2.8 S.C. FD 50mm *f*-1.4 S.S.C. FL 50mm *f*-1.4	FD 35mm *f*-3.5 S.C. FL 28mm *f*-3.5 FL 55mm *f*-1.2
Lens Case D	Fish Eye 7.5mm *f*-5.6 S.S.C. FD 100mm *f*-2.8 S.S.C.	FD 50mm *f*-3.5 S.S.C. MACRO FL 85mm *f*-1.8	FD 85mm *f*-1.8 S.S.C.	
Lens Case E	FD 135mm *f*-3.5 S.C.	FD 135mm *f*-2.5 S.C.	FL 135mm *f*-3.5	FD 28-50mm *f*-3.5 S.S.C.
Lens Case F	FD 35-70mm *f*-2.8-3.5 S.S.C.	FL 135mm *f*-2.5 FD 100mm *f*-4 S.S.C. Macro		
Lens Case G	FL 200mm *f*-3.5	FD 80-200mm *f*-4 S.S.C.		
Lens Case H	FL 100mm *f*-3.5			
Lens Case I	Fish Eye FD 15mm *f*-2.8 S.S.C. FD 24mm *f*-1.4 S.S.C. ASPHERICAL	FD 17mm *f*-4 S.S.C. FD 55mm *f*-1.2 S.S.C.	FD 20mm *f*-2.8 S.S.C. FD 55mm *f*-1.2 S.S.C. ASPHERICAL	FD 85mm *f*-1.2 S.S.C. ASPHERICAL
Lens Case J	FD 200mm *f*-4 S.S.C.	FL 200mm *f*-4.5		
Lens Case K	FD 100–200mm *f*-5.6 S.C.	FL 100–200mm *f*-5.6		
Lens Case L	FD 300mm *f*-5.6 S.S.C.			
Lens Case Exclusive (Specify Lens)	TS 35mm *f*-2.8 S.S.C. FL 300mm *f*-5.6 FLUORITE	FD 200mm *f*-2.8 S.S.C.	FD 300mm *f*-5.6 S.C. FL 500mm *f*-5.6 FLUORTTE	FL 55–135mm *f*-3.5
Carrying Case Exclusive (Specify Lens)	FL 400mm *f*-5.6	FL 600mm *f*-5.6	FL 800mm *f*-8	FL 1200 mm *f*-11

LENS CAPS

CAPS	LENSES			
Lens Cap 50mm (metal)	FLM 100mm *f*-4 FL 135mm *f*-3.5	FL 35mm *f*-3.5 FL 200mm *f*-4.5	FL 50mm *f*-1.8	FL 100mm *f*-3.5
Lens Cap C-55	FD 24mm *f*-2.8 S.S.C. FD 35mm *f*-2 S.S.C. FD 85mm *f*-1.8 S.S.C. FD 100–200mm *f*-5.6 S.C.	FD 28mm *f*-3.5 S.C. FD 50mm *f*-3.5 S.S.C. MACRO FD 100mm *f*-2.8 S.S.C. FD 300mm *f*-5.6 S.S.C.	FD 28mm *f*-2.8 S.C. FD 50mm *f*-1.8 S.C. FD 135mm *f*-3.5 S.C.	FD 35mm *f*-3.5 S.C. FD 50mm *f*-1.4 S.S.C. FD 200mm *f*-S.S.C.
Lens Cap C-58	TS 35mm *f*-2.8 S.S.C. FD 135mm *f*-2.5 S.C.	FD 55mm *f*-1.2 S.S.C. FD 300mm *f*-5.6 S.C.	FD 55mm *f*-1.2 S.SC. ASPHERICAL	
Lens Cap 60mm (metal)	FL 300mm *f*-5.6 FLUORITE FL 50mm *f*-3.5 FL 135mm *f*-2.5	FL 28mm *f*-3.5 FL 50mm *f*-1.4 FL 200mm *f*-3.5	FL 55mm *f*-1.2 FL 55–135mm *f*-3.5	FL 35mm *f*-2.5 FL 85mm *f*-1.8
Lens Cap 69mm (metal)	FD 35–70mm *f*-2.8-3.5 S.S.C.		FD 28-50mm *f*-3.5 S.S.C. ASPHERICAL	
Lens Cap 75mm (metal)	FD 17mm *f*-4 S.S.C.	FD 20mm *f*-2.8 S.S.C. FD 85-300mm *f*-5	FD 24mm *f*-1.4 S.S.C. ASPHERICAL	
Lens Cap 78mm	FD 200mm *f*-2.8 S.S.C.			
Lens Cap 94mm	FD 85–300mm *f*-4.5 S.S.C.			
Lens Cap 90mm (metal)	FL 400mm *f*-5.6			
Lens Cap 125mm (metal)	FL 600mm *f*-5.6	FL 800mm *f*-8	FL 1200mm *f*-11	
Lens Cap Exclusive	Fish Eye FD 15mm *f*-2.8 S.S.C.			
Lens Cap S-72	FD 24–35mm *f*-3.5 S.S.C. ASPHERICAL			

LENS HOODS

HOOD	LENSES			
Lens Hood BW-55A in Case	FD 35mm *f*-3.5 S.C.	FD 35mm *f*-2 S.S.C.	FD 35–70mm *f*-2.8-3.5 S.S.C.	
Lens Hood BW-55B in Case	FD 24mm *f*-2.8 S.S.C.	FD 28mm *f*-3.5 S.C.	FD 28mm *f*-2.8 S.C.	
Lens Hood BW-58B in Case	TS 35mm *f*-2.8 S.S.C.			
Lens Hood BS-55	FD 50mm *f*-1.8 S.C.	FD 50mm *f*-1.4 S.S.C.		
Lens Hood BS-58	FD 55mm *f*-1.2 S.S.C.	FD 55mm *f*1.2 S.S.C. ASPHERICAL		
Lens Hood BT-55	FD 85mm *f*-1.8 S.S.C.	FD 100mm *f*-2.8 S.S.C.	FD 135mm *f*-3.5 S.C.	
Lens Hood W-50	FL 35mm *f*-3.5			
Lens Hood W-60 in Case	FL 28mm *f*-3.5	FL 35mm *f*-2.5		
Lens Hood S-50 in Case	FL 50mm *f*-1.8			
Lens Hood S-60 in Case	FL 50mm *f*-1.4	FL 50mm *f*-3.5	FL 55mm *f*-1.2	FL 55–135mm *f*-3.5
Lens Hood T-50	FL 100mm *f*-3.5	FL 135mm *f*-3.5		
Lens Hood T-60	FL 85mm *f*-1.8	FL 135mm *f*-2.5	FL 200mm *f*-2.5	
Rubber Hood W-69	FD 35–70mm *f*-2.8-3.5 S.S.C. FD 28–50mm *f*-3.5 S.S.C.			
Lens Hood W-75	FD 24–35mm *f*-3.5 S.S.C. ASPHERICAL			

DUST CAPS

DUST CAP	LENSES			
Dust Cap	FL 400mm *f*-5.6	FL 600mm *f*-5.6	FL 800mm *f*-8	FL 1200mm *f*-11 Lens Head
Dust Cap R-F	All FD Lenses	All FL Lenses	All R Lenses	
Finder Dust Cover	Servo EE Finder Eye Level Finder	Booster T Finder	Speed Finder	Waist Level Finder

Dust Caps cover the back end of lenses when removed from camera.

CAMERA CASES

CAMERA CASE	CAMERA
Leather Case S	F-1 with 50mm *f*-1.4, *f*-1.8
Leather Case L	F-1 with 55mm *f*-1.2
Case S	A-Series or EF with 50mm
Case L	A-Series or EF with 55mm
Eveready Case S	FTb, A-series with 50mm
Eveready Case L	FTb, A-series with 55mm
Eveready Case S	TX, TLb
Case	Servo EE Finder
Case	Booster T Finder
Case	Speed Finder
Action Case	A-Series with Power Winder

BATTERIES

EQUIPMENT	NO. OF BATTERIES	TYPE
A-1	1	6V Silver Oxide (#544)
AE-1	1	6V Silver Oxide (#544)
AT-1	1	6V Silver Oxide (#544)
F-1	1	1.3V M20 (#625) (HD)
EF	2	1.3V (M20 (#625)(HD)
FTb	1	1.3V M20 (#625)(HD)
TX	1	1.3V M20 (#625) (HD)
TLb	1	1.3V M20 (#625) (HD)
Motor Drive MD	10	1.5V AA (Battery Magazine 15V)
Motor Drive MF	10	1.5V AA
Servo EE Finder	8	1.5V AA (10 with Motor Drive)
Booster T Finder	8	1.5V AA (1 Eveready #544 6V)
Battery Case	10	1.5V AA (Battery Magazine 15V)
Battery Case	8	1.5V AA (Battery Magazine 12V)
Battery Case D	10	1.5V AA (Battery Magazine 15V)
FTb Booster	2	1.3V M20 (#625) (HD)
Speedlite 133D	4	1.5V AA
Flash Coupler L	2	1.3V M20 (#620) (HD)
Battery Pack MA	18	1.5V AA
Power Winder A	4	1.5V AA
Speedlite 199A	4	1.5V AA
Data Back A	1	6V Silver Oxide (#544)

CANON EQUIPMENT LIST

ITEM	USED WITH	SEE PAGE
F-1 Camera		144-151
A-1 Camera		155-162
AE-1 Camera		163-168
AT-1 Camera		169-173
EF Camera		179-181
FTb Camera		182, 183
TX Camera		184, 185
High Speed Motor Drive Camera		151
FD		18-23
FL, and		40-52
Special Lenses	All cameras	93-103
Motor Drive MA	A-1	175
NiCad Pack MA	Motor Drive MA	176, 177
Battery Pack MA	Motor Drive MA	176, 177
NiCad Charger MA	NiCad Pack A	176, 177
Canon External Battery Pack A	A-series cameras and Power Winder A	176
Wireless Controller LC-1	Motor Drive MA & MF	176
Motor Drive MD Set	F-1	145-149
Includes:		
Battery Case MD	Motor Drive MD	
2-Battery Magazine 15V	Motor Drive MD	
Battery Connector MD	Motor Drive MD	
Battery Checker MD	Motor Drive MD	
Remote Switch MD	Motor Drive MD	
Extension Cord MD10	Motor Drive MD	
Battery Case D	Clips directly to Motor Drive MD instead of cable-connected Battery Case MD	149
Motor Drive MF Set	F-1	145-149
Includes: Grip MF	Motor Drive MF	
Cord MF for Grip MF	Extension cord for Grip MF	
Remote Switch 60MF	Remote control for Motor Drive MF, 0.6 meters long	
Extension Cord E1000	Extension cord for Remote Switch 60MF, 10 meters long	
Interval Timer L	Motor Drive MF. Times exposures from half-second to 3-minute intervals	
Film Chamber 250 Set Includes:	F-1, with or without motor drive	149-151
Film Chamber 250	Film Chamber 250	
2-Film Magazine 250	Film Chamber 250	
Film Loader 250	Film Chamber 250	151
Power Winder A	A-1, AE-1, AT-1	174, 175
Battery Pack A	Power Winder A	
Servo EE Finder Set	F-1	72-74
Includes: Power Cord 12V2E	Servo EE Finder to Battery Case	
Battery Case for Servo EE (Same as Battery Case MD) Includes:	Servo EE Finder	
Battery Magazine 12V	Servo EE Finder	
Battery Case with Battery Magazine 15V	Servo EE Finder with Motor Drive MD	
Connecting Cord MF for Servo EE Finder	Connects Servo EE Finder to batteries in Grip MF when used with Motor Drive MF	
Booster T Finder Set Includes: 6-volt battery	F-1	70-72
Power Cord 6-volt 2B	In cold weather, removes power drain from internal battery and supplies power to Booster T separately from a Battery Case MD with Battery Magazine 12V.	
Speed Finder in case	F-1	57
Waist-Level Finder	F-1	56
Angle Finder A2	All cameras but reversed image	56
Angle Finder B	All cameras with correct image	56, 57
Magnifier R Includes: Canon Magnifier and Adapter R to mount on F-1 viewing eyepiece	F-1	56
Magnifier S Includes: Canon Magnifier and Adapter S to mount on "Square" eyepieces	AE-1, AT-1, EF, FTb, TX, TLb	56
Magnifier Adapter R	Canon Magnifier	
Magnifier Adapter S	Canon Magnifier	
Interchangeable Focusing Screens	F-1	58, 146
Dioptric Adjustment Lens R(+3), R(+2), R(+1), R(+0.5), R(0), R(-0.5), R(-2), R(-3), R(-4)	F-1 to adapt eyepiece optics to user's eyeglass prescription. F-1 viewing optic is -1 diopters without adjustment lens installed.	56
Dioptric Adjustment Lens S(+3), S(+2), S(+1.5), S(+1), S(+0.5), S(0), S(-0.5), S(-2), S(-3), S(-4)	A-1, AE-1, AT-1, EF, FTb, TX, TLb to adapt eyepiece optics to user's eyeglass prescription. Camera viewing optic is 1 diopters without adjustment lens installed.	56
Canon Booster in case	FTb in dim light	68-69
Eye Cup 3R	F-1 (Included with camera body)	56
Eye Cup 4S	A-1, AE-1, AT-1, EF, FTb, TX, TLb (Included with EF)	56
Speedlite 155A	A Series	135-137

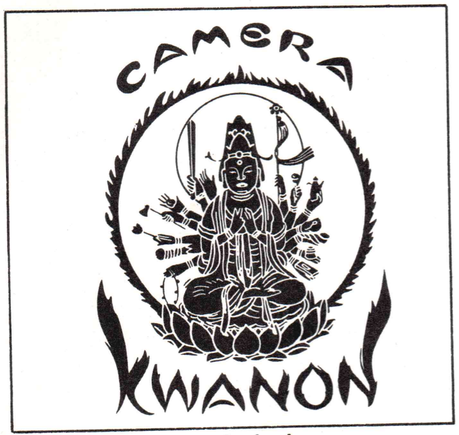
CANON EQUIPMENT LIST

ITEM	USED WITH	SEE PAGE
Synchro Cord A	Speedlite 155A and 199A	137
Speedlite 199A	A series	133-137
Wide Adapter	199A	134, 160
Battery Magazine D	199A	137
A-33 Automatic Flash	All cameras	131, 132, 136, 137
AB-46 Automatic Flash	All cameras	132, 133, 136, 137
AB-56 Automatic Flash	All cameras	132, 133, 136, 137
Data Back A	A-Series	178
Synchro Cord D	Cord connects A-33, AB-46 or AB-56 to X-sync flash terminal of any camera with standard push-in fitting.	137
Wide-Adapter AB-46	Changes beam width of AB-46 flash unit to cover 28mm lens	137
Wide Adapter AB-56	Changes beam width of AB-56 flash unit to cover 28mm lens.	137
Sensor Adapter AB-56	Attach removable light sensor of AB-56 flash to camera hot shoe.	137
Speedlite 133D with Flash Auto Ring A2 (CAT)	F-1, EF, FTb, but not all lenses	129
Speedlite 133D with Flash Auto Ring B2 (CAT)	F-1, EF, FTb, but not all lenses	129
Flash Auto Ring A2	Speedlite 133D for CAT flash system	130
Flash Auto Ring B2	Speedlite 133D for CAT flash system	130
Flash Coupler L	F-1 with CAT flash. (Also illuminates viewfinder display)	130
Flash Coupler D	F-1 with flash other than CAT system	130
Gadget Bag 4	Medium-sized hard case for any camera with lenses and accessories	138
Gadget Bag G-1	Larger deluxe hard case for any camera with lenses and accessories	138
Camera Holder F	All cameras on tripod or copy stand	89
Tripod Adapter A	Use between A-series camera and tripod	
Canon Release 30	Cable release for all cameras 30cm long	
Canon Release 50	Cable release for all cameras 50cm long	
Self Timer 8	TX, TLb Screws into shutter button and gives 5 to 10 seconds time delay for cameras without built-in self timers.	
Copy Stand 4	All cameras	89
Handy Stand F55 set	All cameras	91
Photo Micro Unit F	All cameras—adapts camera to microscope	91
Macro Hood	Fits on forward end of reversed lenses, automatically sets FD lenses for manual control of aperture.	85
Microphoto Hood	All cameras—adapts camera to microscope	91
Extension Tube FL15	All cameras with no mount converter necessary. Preserves automatic aperture, but stopped-down metering necessary. Gives 15mm extension.	82-86
Extension Tube FL25	Same as Extension Tube FL15, except gives 25mm extension. FL15 and FL25 should not be stacked.	82-86
Extension Tube M Set Includes: 1-Extension Tube M5 1-Extension Tube M10 2-Extension Tube M20	All cameras. Can be stacked. Breech-Lock mounts, so no mount converter required.	82-86
Extension Tube M5	All cameras, 5mm extension	82-86
Extension Tube M10	All cameras, 10mm extension	82-86
Extension Tube M20	All cameras, 20mm extension	82-86
Extension Tube A (6mm)	Lens Mount Converters A and B	82-86
Extension Tube B (9mm)	Lens Mount Converters A and B	82-86
Extension Tube C (12mm)	Lens Mount Converters A and B	82-86
Additional Screw-type Extension Tubes: (Nomenclature is extension in millimeters)		82-86
Extension Tube 25	Lens Mount Converters A and B	
Extension Tube 50	Lens Mount Converters A and B	
Extension Tube 75	Lens Mount Converters A and B	
Extension Tube 100	Lens Mount Converters A and B	
Extension Tube 150	Lens Mount Converters A and B	
Extension Tube 200	Lens Mount Converters A and B	

CANON EQUIPMENT LIST

ITEM	USED WITH	SEE PAGE
Extension Tube ABC Set (Screw type) Includes: Extension Tube A Extension Tube B Extension Tube C	All cameras (requires Lens Mount Converters A and B)	82-86
Extension Tube FD 25	50mm Macro Lens	84-85
Extension Tube FD 50	100mm Macro Lens	85
55 Macrophoto Coupler	Mounts lens in reversed position, fits 55mm screw threads of lens filter ring. Can be screwed to forward end of any Canon screw-type extension ring, or mounted on camera body using Lens Mount Converter A.	84
58 Macrophoto Coupler	Same as above except fits 58mm filter threads on lens.	84
48 Macrophoto Coupler	Same as above except fits 48mm filter threads on lens.	84
FL55 Macrophoto Coupler	Mounts lens in reverse using 55mm filter threads on lens. Opposite end has Breech-Lock Mount, so fits camera body directly without converter. Also fits on forward end of Extension Tube M. Has built-in helicoid with 13mm travel for extension distance adjustment.	84
FL58 Macrophoto Coupler	Same as above except fits 58mm filter thread.	84
FL48 Macrophoto Coupler	Same as above except fits 48mm filter thread.	84
Lens Mount Converter A	Fits between screw-type extension tubes and Breech-Lock Mount on camera body.	83
Lens Mount Converter B	Fits between screw-type extension tubes and Breech-Lock Mount on rear of Canon lens.	83
Lens Mount Converter E	Adapts Canon camera body to mount Topcon/Exacta bayonet-mount lenses and accessories with stopped-down metering and manual aperture control.	
Lens Mount Converter P	Adapts Canon camera body to mount Pentax/Praktica threaded lenses and accessories with stopped-down metering and manual aperture control.	
55 Close-Up 450	55mm filter threads on lens	81
55 Close-Up 240	55mm filter threads on lens	81
58 Close-Up 450	58mm filter threads on lens	81
58 Close-Up 240	58mm filter threads on lens	81
48 Close-Up 450	48mm filter threads on lens	81
48 Close-Up 240	48mm filter threads on lens	81
Bellows FL	All cameras	86
Bellows M	All cameras	86
Slide Duplicator 48	Bellows FL and lens with 48mm filter thread	89
Slide Duplicator 55	Bellows FL and lens with 55mm filter thread	89
Attachment Ring 48 for Slide Duplicator	Converts Slide Duplicator 55 to also use lenses with 48mm filter thread.	89
Attachment Ring 55 for Slide Duplicator	Converts Slide Duplicator 48 to also use lenses with 55mm filter thread.	89
Attachment Ring 58 for Slide Duplicator	Converts Slide Duplicator 48 or 55 to also use lenses with 58mm filter thread.	89
Filters	All cameras	119
Camera Cases	All cameras	187
Batteries	All cameras	187
Lens Cases		186
Lens Hoods		187
Lens Caps		186
Dust Caps	All cameras	187
Camera Cover R-F (body cap)	All cameras	
Action Grip	A-1	177

BRIEF HISTORY OF Canon



The original Canon insignia.

In 1929, a German zeppelin stopped at Japan on a world tour. Technical people from a small Japanese company, Precision Optical Research Laboratory, saw a Leica 35mm camera with focal-plane shutter and were impressed.

This small laboratory had been founded by a medical doctor, Dr. Mitarai, to research and develop medical optical devices. It grew into Canon Inc., with a wide range of electronic and optical products of which medical equipment is still an important part.

The early exposure to Leica sparked their interest in photographic cameras and in 1935 this group designed and built a 35mm focal-plane camera which they called the *Kwanon,* meaning "Goddess of Mercy."

That was the beginning of Canon cameras. The *Kwanon* was a laboratory model, not suited for production, but it led to another model, called the *Original*, which was placed on the market.

In 1939, the company began manufacturing their own lenses under the trade name *Serenar*—the direct ancestor of all modern Canon lenses. The first *Serenar* was a 50mm *f*-3.5.

In 1947, the company changed its name and trademark to *Canon.*

An X contact for electronic flash was introduced in 1953, along with a new 50mm, *f*-1.5 lens—the fastest standard lens in the world at that time.

The first organization of Canon camera users, the *Canon Circle* was formed in 1954.

With the Model *V-T* in 1956, Canon introduced a 50mm *f*-1.2 lens, getting closer to the theoretical limit of lens speed. Canon discontinued Leica-style film loading through the bottom of the camera and started loading through the back of the camera—similar to current practice. The *V-T* had a built-in self-timer with adjustable delay. A trigger on the bottom of the camera advanced the film.

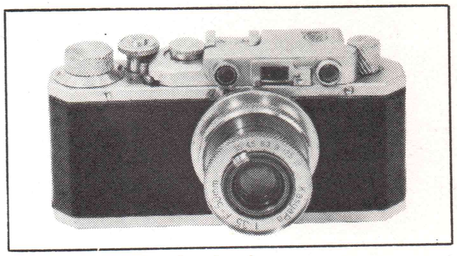
1957 saw the film-advance lever moved to the top of the camera, in the back of the top plate, the addition of a rewind crank rather than just a simple knob, and development of a metal focal-plane shutter made of black epoxy-coated stainless steel.

With the *VI-T* in 1958 came the frame counter coupling to the back cover, allowing automatic reset of the frame counter to S when the back was opened.

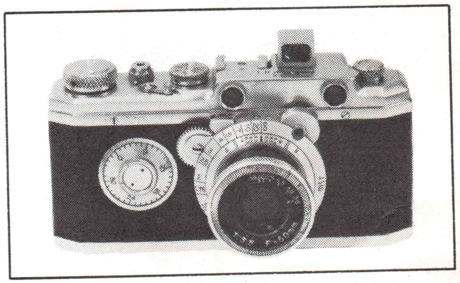
In 1959, Canon introduced its first SLR camera, the *Canonflex R*. This is a very satisfactory camera even today and has many of the features found in the latest Canon models. It offered eye-level viewing with a detachable pentaprism giving an upright and non-reversed image and a waist-level finder was available as an accessory.

The respected Canon lens mount for SLR cameras was introduced with the *Canonflex* camera and has not changed since.

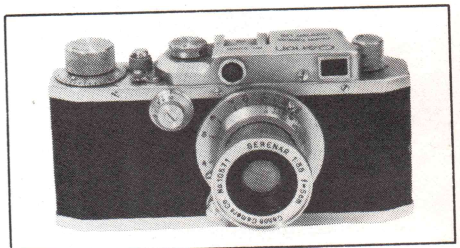
The *Canonflex/R 2000*, introduced in 1960 had the world's first focal-plane shutter operating at 1/2,000 second. The same year saw Canon's first automatic-expo-



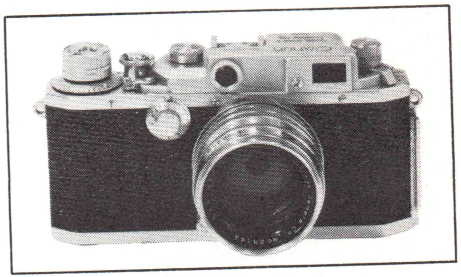
Kwanon — **The beginning.**



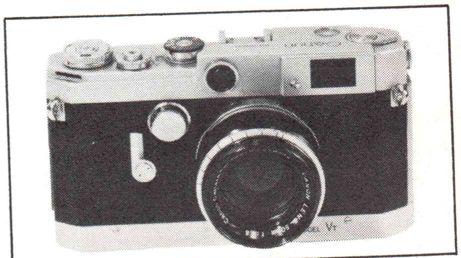
Original — **First production model.**



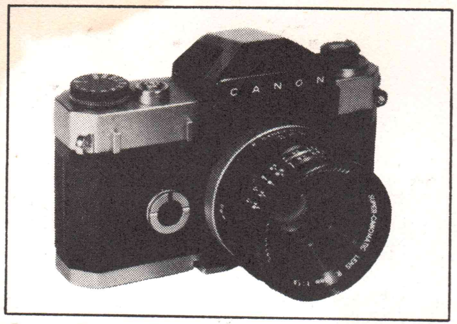
S-II — **With Canon's own lens.**



IV-SB — **First X-sync contact.**



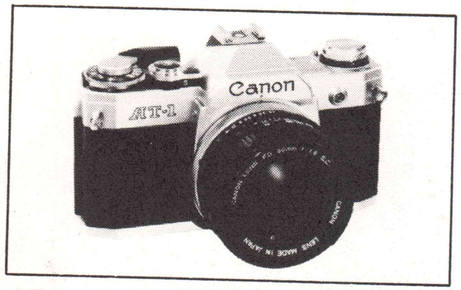
V-T — **Back loading with automatic frame counter reset.**



Canonflex — **First Canon SLR introduced Canon's breech-lock lens mount.**

FD **lens introduced in 1971 with** ***F-1*** **and** ***FTb*** **cameras.**

AE-1 — **First with computer-type Central Processing Unit.**



AT-1 — **A match-needle version of the AE-1.**

A-1 — **First with built-in digital processor and six modes of operation.**

sure camera, the *Canonet*—a rangefinder camera—not an SLR.

In 1962, the *Canonflex RM* was produced with a built-in exposure meter internally coupled to the shutter-speed control. The exposure meter viewed the scene through a separate window, not through the lens.

In 1963, Canon exhibited a test-model camera, the *AF* with both fully automatic exposure control and automatic focusing! Another "world's first!" The automatic-focusing feature has not been put in production on any standard Canon cameras.

In 1964, Canon dropped the trade name *Canonflex*—used to designate SLR cameras—and began model designations such as the *FX*. This new model put the film-advance lever on the top of the camera top-plate—now standard on virtually all brands of SLR cameras, including all current Canon models.

A lock was added to the shutter-release button, and a mirror lock held the mirror in the raised position. With the *FX* camera, the new series of FL lenses was introduced, giving the added convenience of automatic aperture operation by the camera mechanism. During this time, automatic exposure control in rangefinder cameras was being steadily improved, and the Quick Load (QL) was developed for the *Canonet QL 17*. Both developments turned up later in SLR cameras.

In 1966, the *Pellix* with a stationary semi-reflecting mirror was announced.

In the same year, an improved SLR with a conventional moving mirror and QL film loading was announced as the *FTQL*. This was the first model to use semi-spot metering with an angled beamsplitter in the condenser above the viewing screen. This metering system is still used in the F-1 and FTb.

The *FTb* introduced in 1971 replaced the *FTQL*. This camera and those which followed are the subjects of this book. The *F-1* was marketed in 1971; the *TLb* in 1972; the *EF* in 1974; the *TX* in 1975; the *AE-1* in 1976; the *AT-1* in 1977.

In 1978, Canon introduced the A-1 camera. In their words, this camera "ends the argument" about which type of automatic operation is best by offering every conceivable type of operation—all in one camera.

In its growth to an international sales volume approaching a half-billion dollars annually, Canon achieved an impressive record of "firsts" in cameras, optics, and other products. The F-1 with Servo EE Finder and Motor Drive was the first production camera system with these capabilities. In lenses and optics, Canon developed the first production lens with an aperture of 0.95—used on rangefinder camera models. Canon was first to produce large man-made fluorite crystals and successfully mass-produce telephoto lenses with fluorite elements. The first successful production of aspherical lenses in quantity began in 1974.

A series of "firsts" in the application of electronics to SLR cameras began with the AE-1 and continues with the A-1. The A-1 is obviously the first to have five different automatic modes of operation. The astonishing versatility of this camera is due to use of a digital computer in the camera—another first. Every "input" that affects exposure is converted to a digital electronic signal which is then handled in the camera's built-in computer in much the same way as the giant industrial and business computers that handle large quantities of data and solve problems with amazing speed.

During its rapid growth, Canon has become a truly international company with manufacturing plants in Japan, The United States, Taiwan, West Germany and Australia. Sales and service facilities are worldwide.

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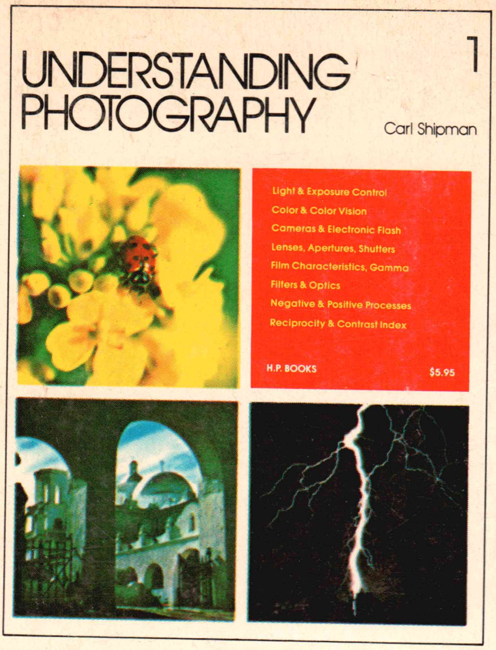
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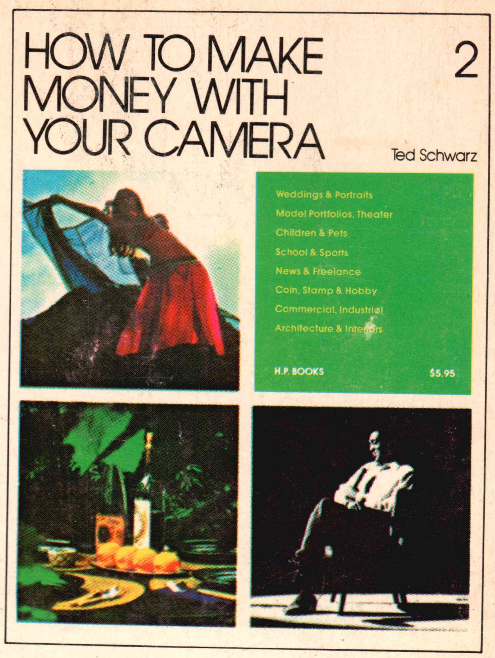
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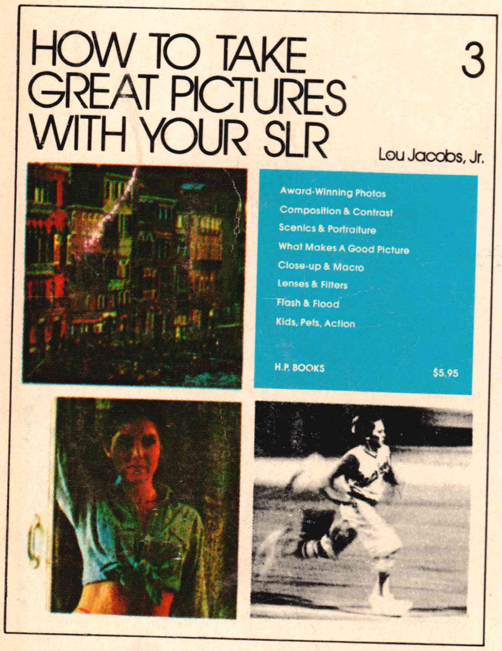
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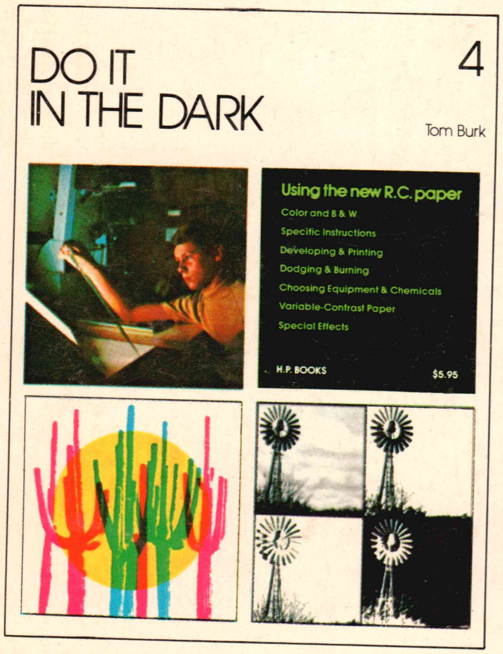
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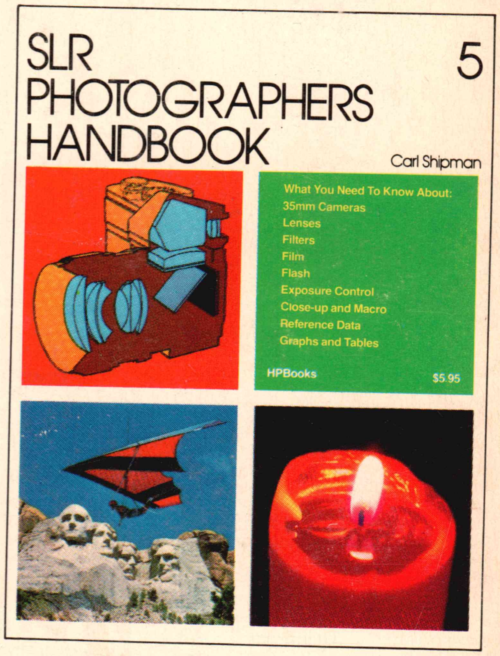
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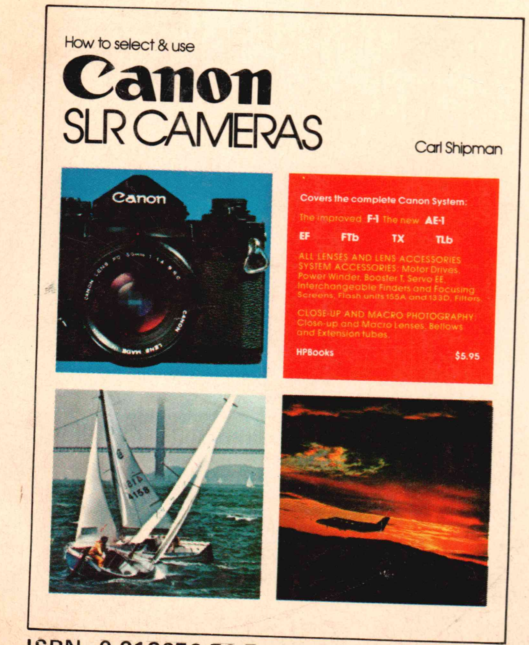
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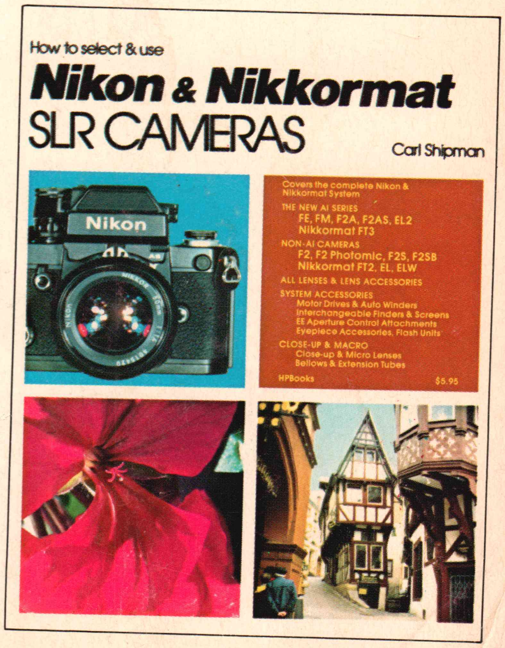
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